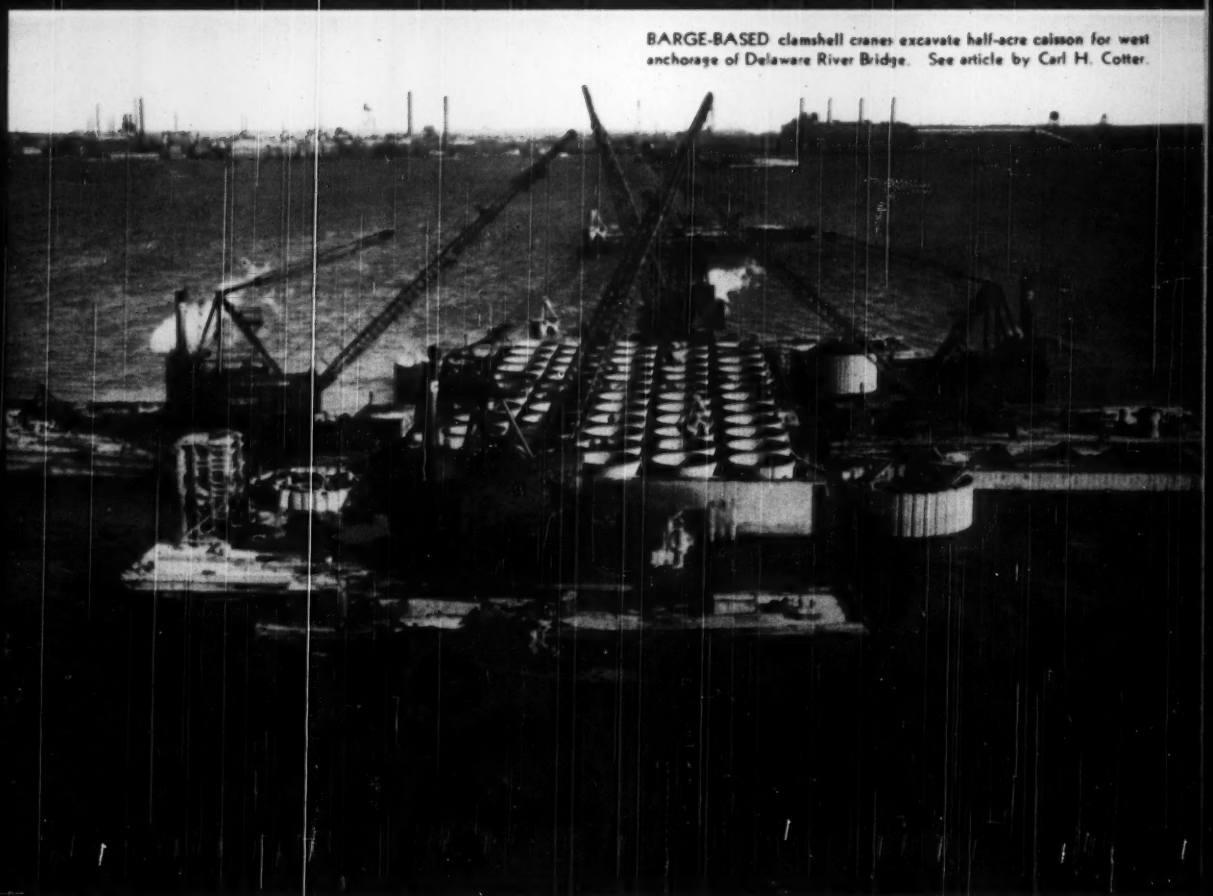
CIVIL ENGINEERING

NOVEMBER
1950

THE MAGAZINE OF ENGINEERED CONSTRUCTION



BARGE-BASED clamshell cranes excavate half-acre caisson for west anchorage of Delaware River Bridge. See article by Carl H. Cotter.

Chicago Water System Serves Growing Population with Decreased Pumpage—DeBerard

Can We Provide Protection Against Atomic Weapons?—Amirikian

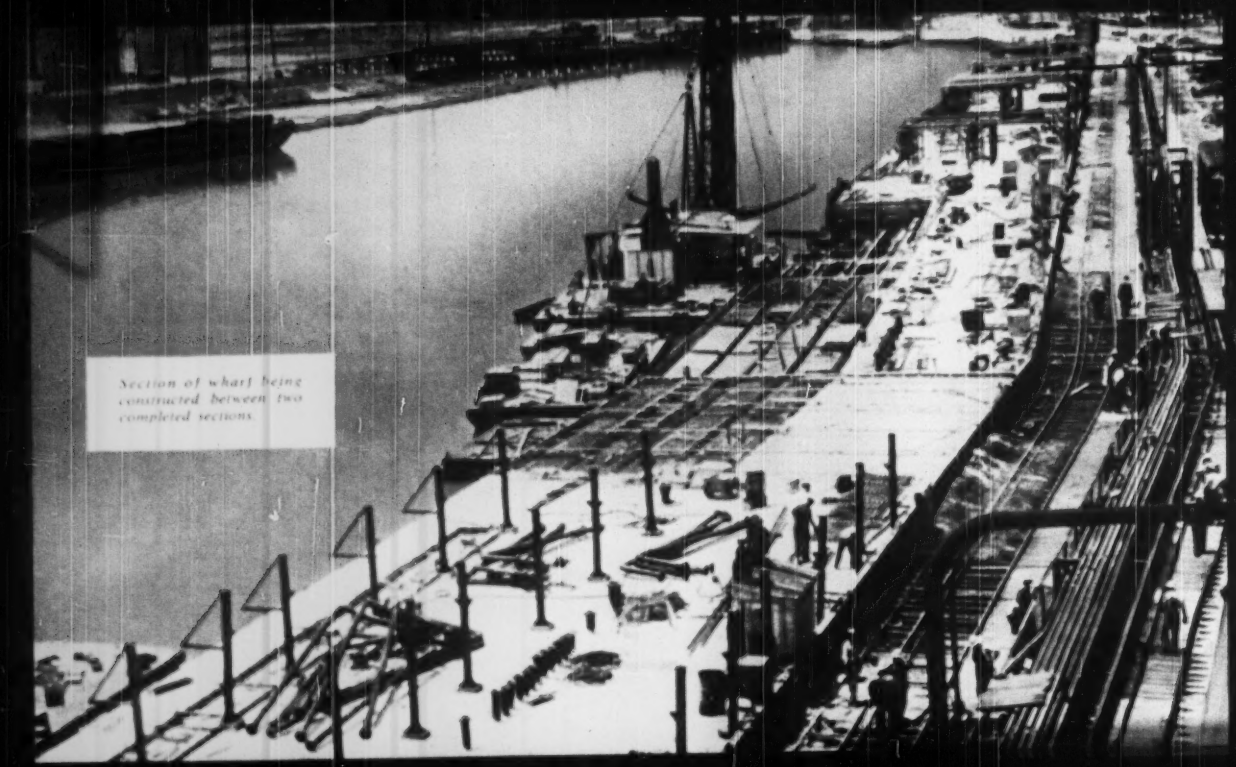
You Can't Buy National Defense—Jelley

RAYMOND

SERVING GULF OIL FOR 40 YEARS

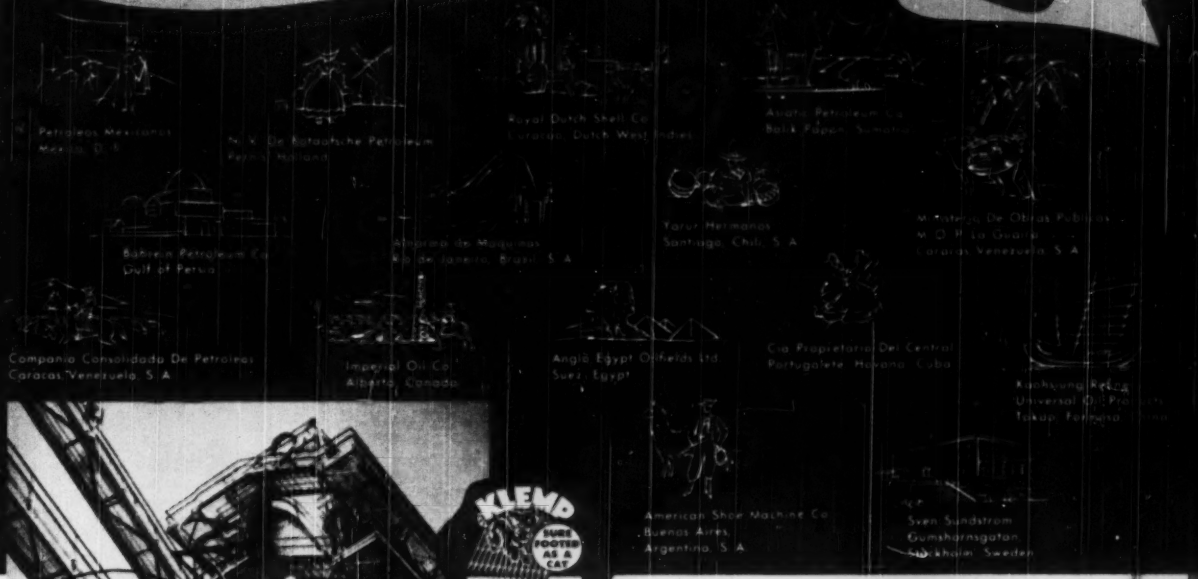
THROUGH THE YEARS,

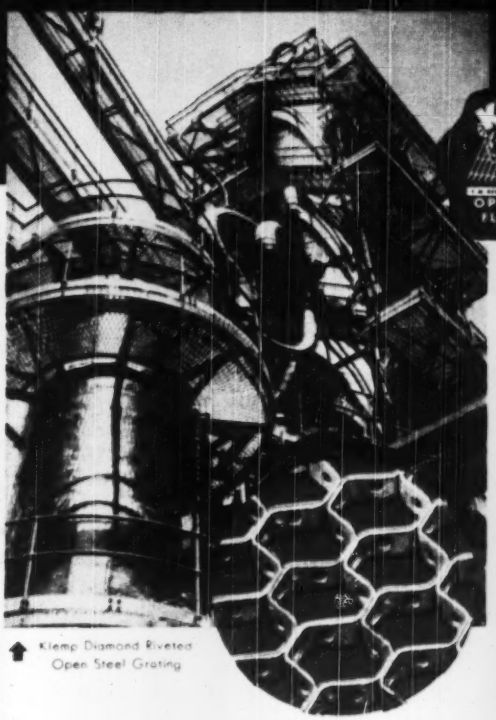
RAYMOND



Section of wharf being constructed between two completed sections.

Far Away Places--and Strange Sounding Names....





KLEMP
SURE FOOTED AS A CAT
OPEN STEEL FLOORING

⬆ Klemp Diamond Riveted Open Steel Grating

Klemp HEXTEEL ⬆
Gannister Lining Reinforcement Meshes for Cat Crackers and Pipe Lines

Factories in Chicago and Houston
Sales Representatives in
102 U. S. Cities and 33 Foreign Countries

SEE YOUR CLASSIFIED TELEPHONE DIRECTORY UNDER GRATINGS

KLEMP

World's Largest Manufacturer of Open Steel Meshes

The WM. F. KLEMP COMPANY for more than 43 years has shipped its open steel and aluminum grating and treads, gannister lining reinforcement meshes, and open steel and aluminum bridge deckings to the leaders of industry, construction and commerce in the four corners of the world.

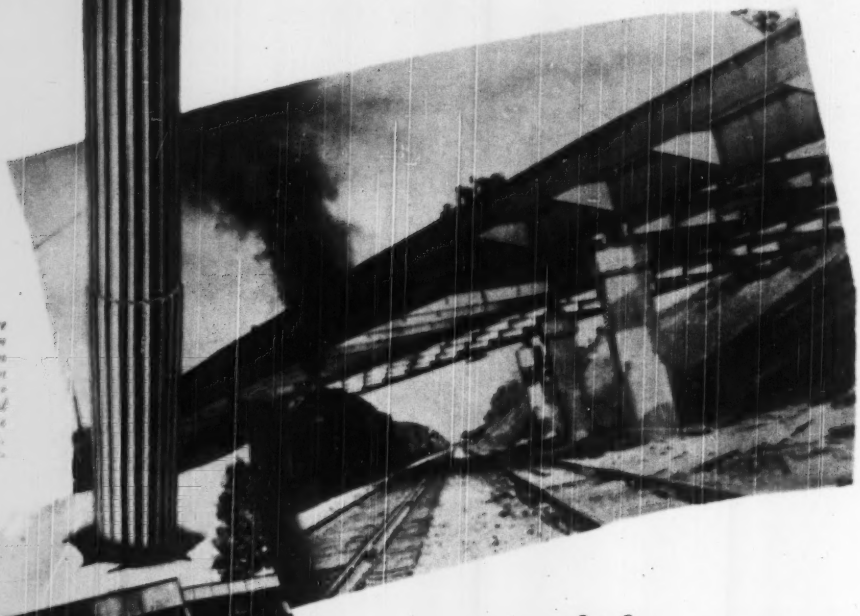
● *Send for our new catalogs!* See how we meet the needs of modern industry by fabricating the following superior products to our customers' exacting specifications:

KLEMP HEXTEEL HEAVY DUTY SURFACE ARMOR
KLEMP DIAMOND RIVETED OPEN STEEL GRATING
KLEMP SERRATED GRATING & TREADS
KLEMP SPANSTEEL EXPANDED METAL
KLEMP FLOORSTEEL FLEXIBLE FLOOR ARMOR
KLEMP ELECTRO-FORGED GRATING & TREADS
KLEMP FLEXSTEEL CONVEYOR BELTS
KLEMP STEEL SAFETY MATS

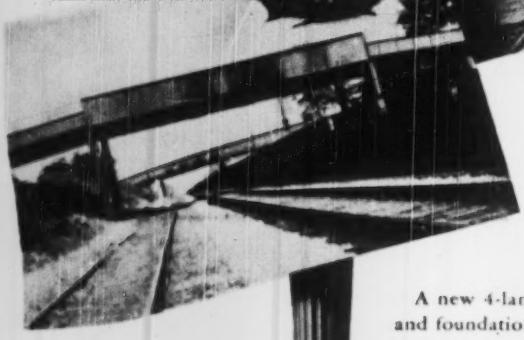
Our specialized experience in solving difficult flooring and pipe and vessel lining problems is at your service. Write for our new catalogs *today!*

WM. F. KLEMP COMPANY
6610 South Melvina Avenue, Chicago 38, Illinois

BRIDGING A PROBLEM THE MODERN WAY



Thanks to Monotubes, there were no interrupted train schedules while foundation construction went ahead on this new overpass near Ravenna, Ohio. Owned and engineered by Ohio State Highway Department, bridge was built by Wiseman & Company.



Old 2-lane bridge in foreground—a serious traffic bottleneck—replaced by the modern 4-lane bridge on Monotube foundation.

...with Monotubes

YOU'RE looking at another tough construction problem—solved by using Monotube Steel Piles.

A new 4-lane bridge was badly needed. But train traffic was heavy and foundation piles could not be driven from the railroad bed. This meant driving not only at a considerable distance from the crane, but at a much higher elevation than the actual pile cut-offs.

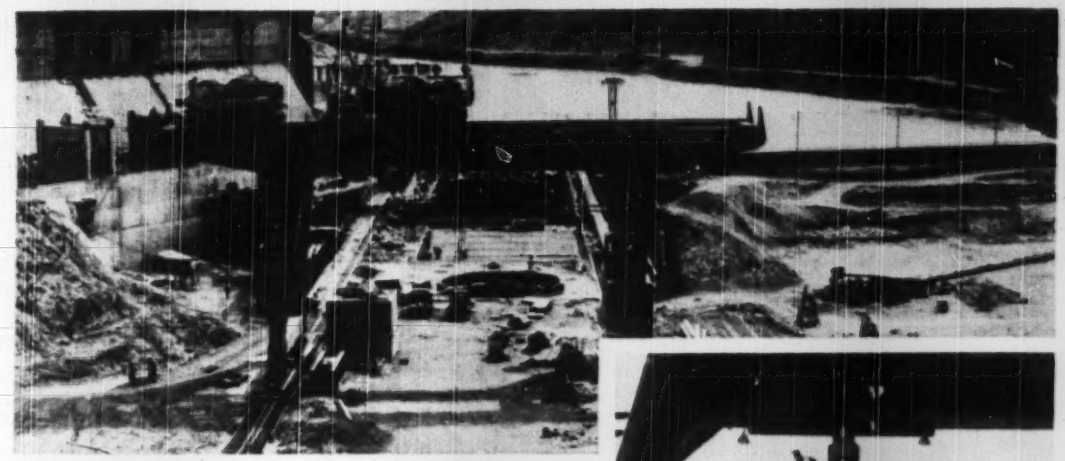
Because Monotubes are sturdy, *yet exceptionally light in weight,* they could easily be driven with light equipment, permitting the needed "overhang". Moreover, it was necessary to batter half the piles in two directions. Again these light, sturdy piles paid off, allowing the use of the same light driving equipment despite the added battering load.

Monotubes help make important time-and-money savings in all kinds of foundation work. They're cold rolled for high strength, offer exceptional stability and structural values, and are easily extended to any length right on the job. They come in sizes, gauges and tapers adaptable to varying soil conditions. A job *started* with Monotubes can be *completed* with them.

Get the facts about *all* the Monotube advantages. You'll see how they can reduce costs time and time again. For complete data, write The Union Metal Manufacturing Company, Canton 5, O.

UNION METAL

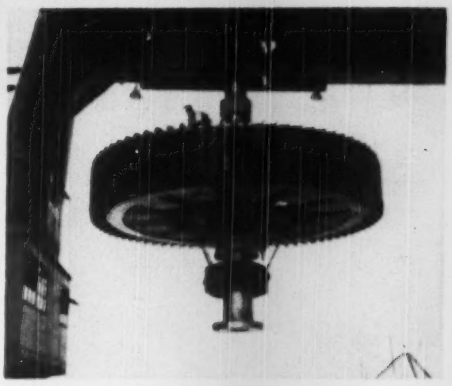
Monotube Foundation Piles



325-ton G-E powered gantry Star Iron and Steel crane at the Davis Dam site on the Colorado River. The crane must operate almost continuously during installation of five turbine generators.

Jogging a 325-ton load 1/10,000 inch at a time

... Electrically



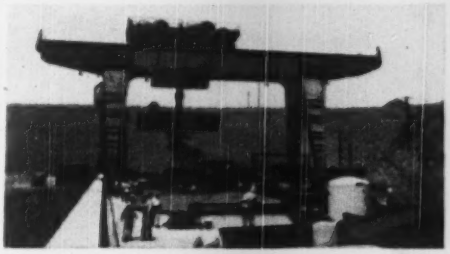
G-E hoist motors and control lift and accurately position turbine-generator rotors weighing over 300 tons.

G-E powered DAVIS DAM CRANE positions heaviest loads accurately, smoothly, safely

It's an unusually versatile crane drive that can either handle an empty hook at twice rated speed, or jog a 325-ton load to within 1/32 inch. Bureau of Reclamation's specifications for Davis Dam outdoor powerhouse crane called for just that type of operation.

The General Electric drive beat the requirements for this job by a wide margin—the full-load jogging accuracy in the lowering direction was .000114 inch.

Electrified construction equipment can work for you too—can give you the fast, safe, efficient service your job calls for. And when you combine G-E motors and control with a G-E power distribution system, you'll get all that electrified equipment can offer with the extra benefits of G-E engineering assistance in application, installation and service. *Apparatus Dept, General Electric Company, Schenectady 5, N. Y.*



From hoist and trolley motors atop the bridge to master switches inside the cab, all G-E equipment on this Star Iron and Steel crane works smoothly to move heavy loads accurately and safely.

Ask him Today!

Whether you buy or build construction equipment, your G-E representative can show you how to do a better job—at lower cost—by complete electrification. Write him now, and he'll call on you at your convenience.

GENERAL ELECTRIC

664-15

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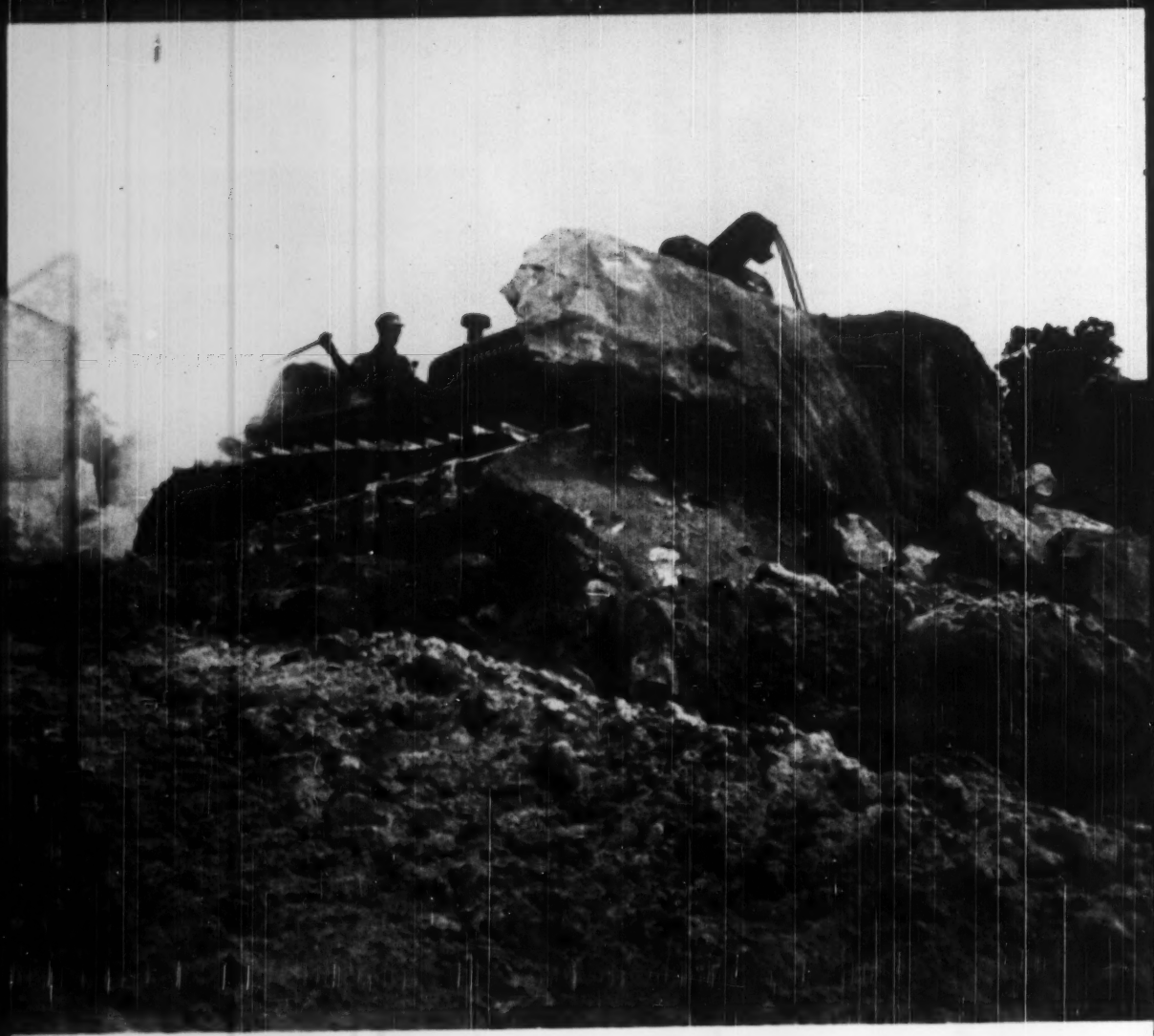
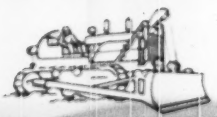
CUSTOMERS'



INTERNATIONAL



CHOICE

The International TD-24 "Champion of Crawlers"

More than 100 International TD-24 diesel crawler tractors have already been delivered to customers by a single International Industrial Power Distributor. Similar strong demand for this new "Champion of Crawlers" all over the country—proves that the TD-24 is customer's choice—every time!

You earthmoving men who have chosen the TD-24 to increase your payload production have given the TD-24 its present place of prominence in the industry. You've proved, on your jobs, that there is nothing like the TD-24 for power and performance. You've found that this "Champion" pays for itself quickly, and then gives you *extra earnings* for the rest of its rugged working life.

We are proud of this tractor—the TD-24—and of the acceptance you have given it. And we're proud of the superb distributor organization which has brought this mighty crawler to you—coast to coast.

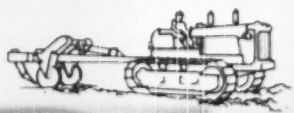
As more International distributors deliver their 100th TD-24 in the months ahead, hundreds more of you who need them will gain the benefits which the great work-capacity and payload production of this "Champion of Crawlers" provides.

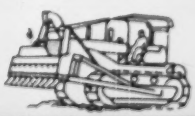
INTERNATIONAL HARVESTER COMPANY

INTERNATIONAL HARVESTER

CHICAGO 1, ILLINOIS

INDUSTRIAL POWER





TIME...

It's our business to cut mapping time—deliver reliable facts to you swiftly . . . economically.

AERO mapping brings double savings. First, it costs very much less than ground surveys. Second, and most important, its speed saves many dollars in time for you.

How much is it worth to your company to begin construction months and even years ahead of schedule? Many of our clients are doing just that. New highways and turnpikes are under construction—new city planning moving ahead—new plant construction advanced by AERO mapping.

Our aerial photographic surveys swiftly deliver low-cost reconnaissance for you in the form of controlled photomosaics. After the area of interest has been narrowed, AERO delivers precise topographic maps—products of the widest photogrammetric experience in the world. They are a sound base for your engineering planning.

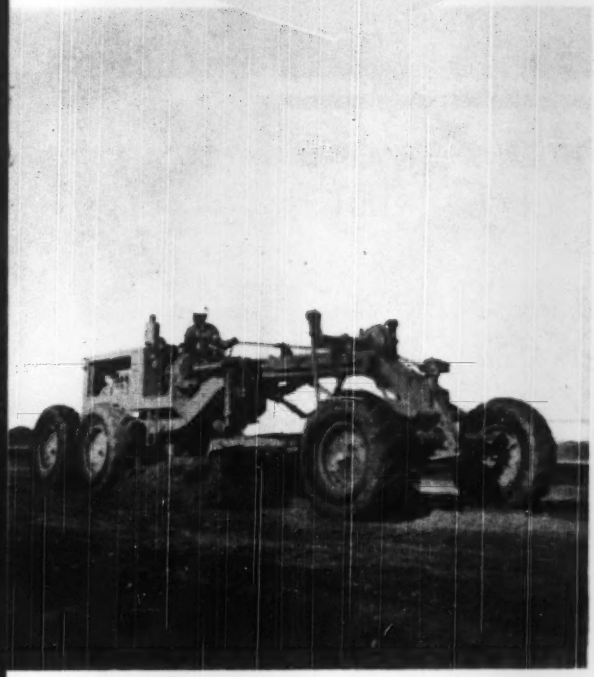
Let AERO's photogrammetric engineers help speed your development. Your inquiry is invited.

AERO MAPS THE FUTURE

AERO
SERVICE CORPORATION
236 E. COURTLAND ST., PHILA. 20, PA.
Oldest Flying Corporation in the World

TOPOGRAPHIC MAPS • PLANIMETRIC MAPS • PRECISE AERIAL MOSAICS • AIRBORNE MAGNETOMETER SURVEYS • RELIEF MODELS • COLOR PHOTOGRAPHY

THE GRADER THAT'S IN A CLASS BY ITSELF



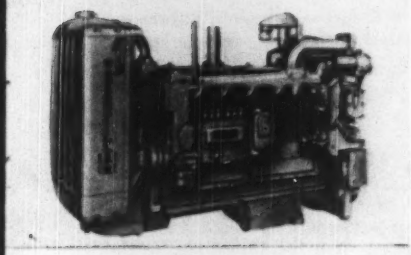
Exclusive bonus features, found only on "Cat" Diesel Motor Graders, make these balanced machines the best you can put on your payroll.

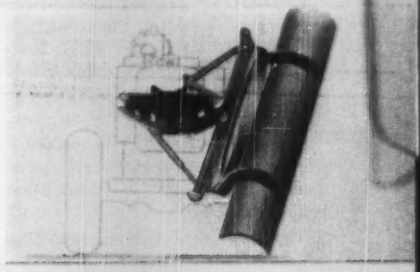
Of his "Cat" No. 12 Motor Grader, which moved more than 30,000 cubic yards of earth during the construction of the Contra Costa County Airport near Concord, Calif., owner Eugene G. Alves says: "I've operated 'Cat' equipment all my life. As far as I'm concerned, nothing can touch it; it's tops in equipment!" And Mr. Alves backs up his opinion by standardizing 100% with "Caterpillar" tools.

On the Contra Costa Airport job, the "Cat" No. 12 Grader has built roads, done grading and drainage structures, and constructed parking areas. With its engine, clutch, transmission, final drive and blade mechanism all *designed* and *built* by "Caterpillar," the machine has the balance and under-the-hide stamina to keep going the way you *hoped* it would when you bid on a job.

When a motor grader operator doesn't have a chance to stand around with his hands in his jeans looking for work, you know he's handling "Cat" equipment. Ask your "Caterpillar" dealer to *show* you his Motor Grader's exclusives.

CATERPILLAR TRACTOR CO. • PEORIA, ILLINOIS





1 **Only** "Cat" Graders have "Cat" Diesel Engines for continuous service and economy of operation. These balanced tools *deliver*.

2 **Only** "Cat" Graders have a box-section blade supporting circle, made from a special angle produced on a "Caterpillar"-owned roll.

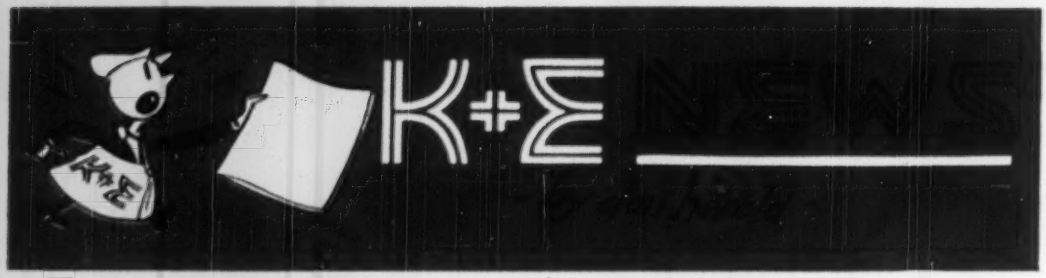
3 **Only** "Cat" Graders have the long radius, curved side shift rack that provides extra lateral shift to the blade assembly, together with the required vertical movement.

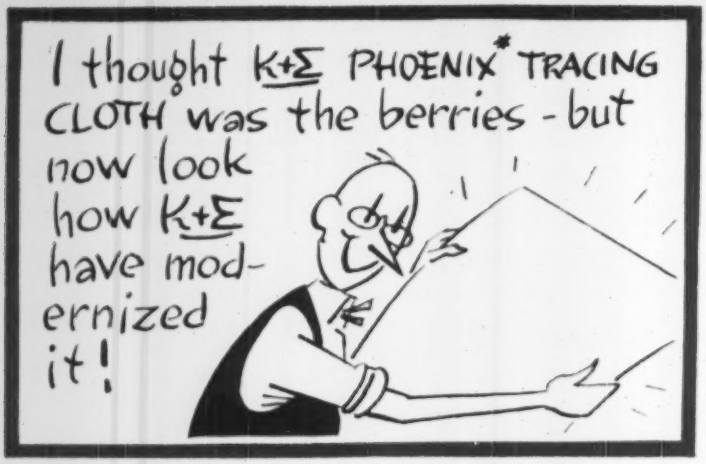
4 **Only** with "Caterpillar" equipment do you buy-in on the world-wide "Caterpillar" dealer service—adequate parts inventory and factory-trained servicemen.

CATERPILLAR

DIESEL ENGINES • TRACTORS

MOTOR GRADERS • EARTHMOVING EQUIPMENT





how good can a tracing cloth get!

PHOENIX* Tracing Cloth always did feel good to an engineer's pencil, but, now, new improved N166 PHOENIX feels better than ever—performs better—is better. It's whiter than ever—which gives it better contrast for pencil line drawings. (This helps reprint transparency.)

The new PHOENIX is toughened to take today's new vigorous printing techniques—repeated trips under higher powered lights or through hotter printing machines.

The new N166 thrives under an ultra-violet test, which equals thousands of prints on a machine, or years of exposure to daylight. No appreciable yellowing.

Improved PHOENIX resists heat of glass cylinders even as high as 250° to 275°. Will not stick.

K&E have also given this cloth a Bureau of Standards three day 212° heat test, which is the equivalent of years of aging. It retains its whiteness remarkably well.

The new PHOENIX resists ammonia vapors and discoloration by contact with diazo prints in storage.

Its surface takes friction heat of motor erasers without softening or stain.

2-way water resistant

Both sides of the new PHOENIX are wonderfully water-resistant. This is important, since, if one side is more water-resistant than the other, the weaker side runs the show. By water, I mean water AND perspiration.

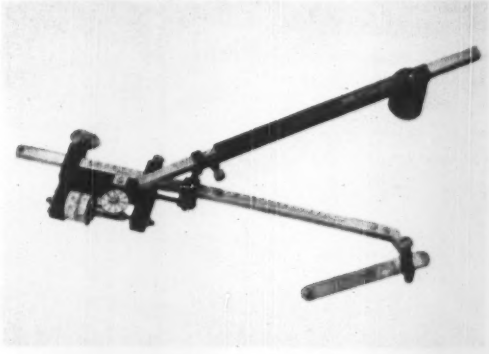
Gosh, I never dreamed I could say so many exciting things about a piece of cloth!

* Trade Mark ®

—and it's loaded with inbuilt K&E precision

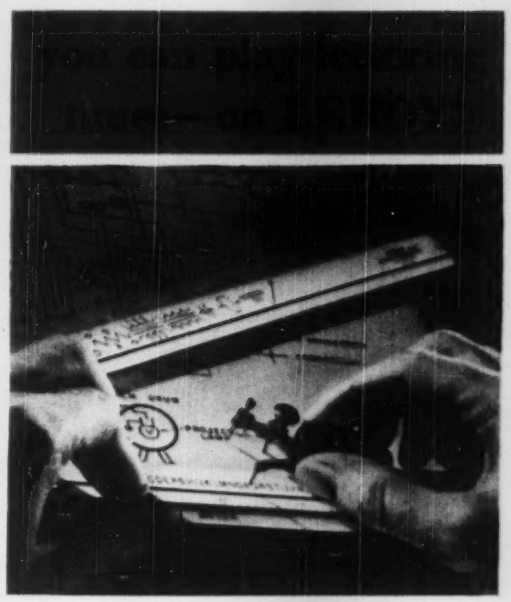
Don't ask me *how* it works. It's Greek to me. But you engineers probably understand that a planimeter will measure the area of an irregular plane if you push a little point accurately around its outline.

Engineers also tell me a planimeter has to be about the most accurate thing on wheels, or it will tell falsehoods. If it has rheumatism in any of its joints, water on the knee, or a crick in its funny bone, watch out.



Engineers tell me that K&E COMPENSATING POLAR PLANIMETERS are built beautifully for long-lasting cat's-whisker precision—that is, unless you go dropping them on the floor or using them to fight mosquitos.

A new K&E Manual comes with each instrument. It includes description of a unique method, which greatly increases the size of the area that can be measured.



LEROY is as versatile as a 1-man band.

You can have standard Gothic alphabets in a variety of sizes, plus many other type styles—Condensed, Extended, Reversed, Outline Gothic, Cheltenham, etc. Everything, including strawberry and vanilla.

Then there are Symbol Drawing Templates—Electrical, Welding, Map, Geological and Mathematical.

Also special templates made specially to order: trade marks and designs, frequently used words and phrases. Tell your K&E distributor or branch or the factory at Hoboken what you want. Send for a "LEROY Lettering and Symbols" booklet.

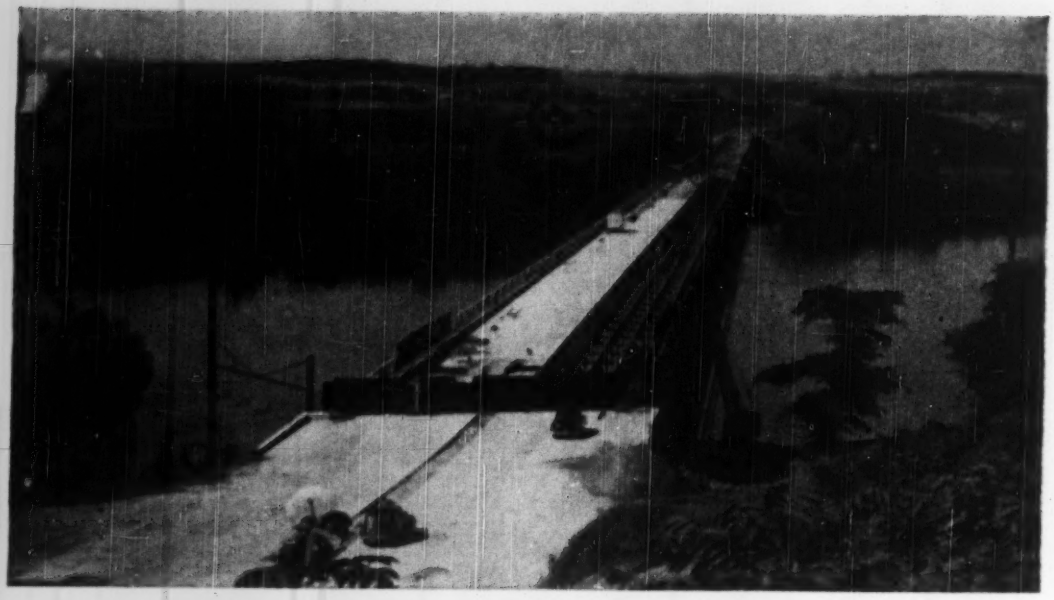
In case you don't know it, LEROY is a "controlled" lettering device used in thousands of drafting rooms. Swift and sweet. No smearing. No swearing.

You can form perfect letters the first time, and achieve speed and skill in a matter of minutes.

For further information about any of the above products, ask a K&E Distributor or any K&E Branch, or write to Keuffel & Esser Co., Hoboken, N. J.

K+E
partners in creating
For 83 years K&E equipment and materials have been partners of the draftsman, engineer and scientist in shaping the modern world.

* Trade Mark ®.



Turnpike Extension Crosses the Susquehanna

Stretching its steel fingers across the Susquehanna River below Harrisburg, this new structure is an important link in the 100-mile-long Philadelphia Extension of the famous Pennsylvania Turnpike.

It is a continuous girder bridge, 4526 ft long, consisting of 46 spans. Its 436-ft girders are continuous over four piers which are spaced at intervals of about 109 ft. The structure is 61 ft wide, and has facilities for four lanes of express traffic, plus walks for pedestrians.

Construction of the superstructure of the Susquehanna River Bridge involved the fabrication and erection of 6727 tons of steel, all of which was handled by Bethlehem.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

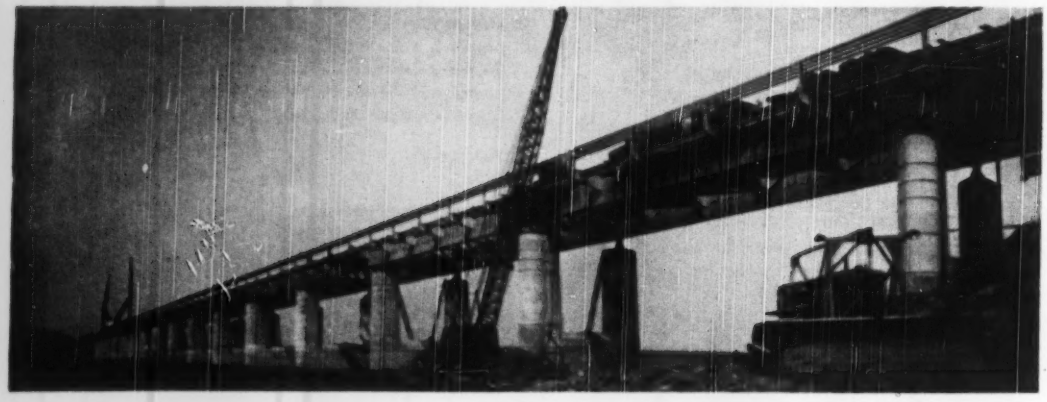
FABRICATED STEEL CONSTRUCTION

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Owner: Pennsylvania Turnpike Commission. *Designing Engineers:* Parsons, Brinckerhoff, Hall & Macdonald, New York. *General Contractors:* Booth & Flinn Company, Pittsburgh



WORLD-WIDE SALES AND SERVICE OF HYSTER TRACTOR EQUIPMENT BY MORE THAN 400 "CATERPILLAR" DEALERS

See your "Caterpillar" dealer for information about Hyster Tractor Equipment, or write for literature.

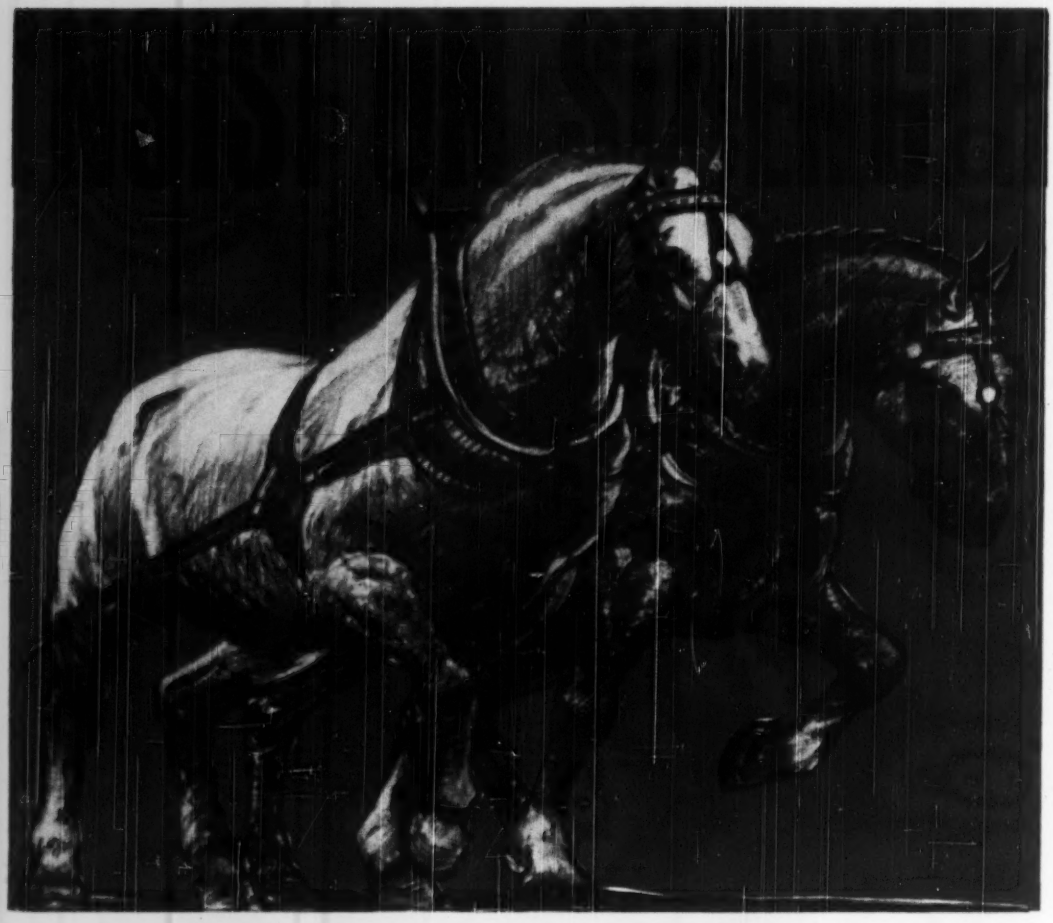
"Caterpillar" dealers around the globe are Hyster tractor equipment sales *and service* stations. They *sell* the right tool for the job. Their factory-trained mechanics *service* the equipment when required. They supply genuine Hyster parts from well equipped stocks.

Hyster has made tractor tools for use with "Caterpillar" track-type tractors for more than twenty years; will continue to design and build quality products for the world's toughest work assignments.

HYSTER® COMPANY

Manufacturer of 29 Tools for "Caterpillar" Track-Type Tractors

2999 N. E. CLACKAMAS, PORTLAND 8, OREGON
1899 NORTH ADAMS ST., PEORIA 1, ILLINOIS



Like a Percheron draft horse cast iron pipe is known for strength

Long life and low maintenance cost of mains laid under city streets depend not only on effective resistance to corrosion but on definite strength factors. The four strength factors that pipe must have to withstand beam stress, external loads, traffic shocks and severe working pressures, are listed on the page opposite. No pipe that is deficient in any of these strength factors should ever be laid in paved streets of cities, towns or villages. Cast iron water and gas mains, laid over a century ago, are serving in the streets of more than 30 cities in the United States and Canada. Such service records prove that cast iron pipe not only resists corrosion but combines all the strength factors of long life with ample margins of safety.

CAST IRON PIPE

in pipe for city streets

No pipe that is deficient in any of the following strength factors should ever be laid under paved streets.

CRUSHING STRENGTH

The ability of cast iron pipe to withstand external loads imposed by heavy fill and unusual traffic loads is proved by the Ring Compression Test. Standard 6-inch cast iron pipe withstands a crushing weight of more than 14,000 lbs. per foot.

BEAM STRENGTH

When cast iron pipe is subjected to beam stress caused by soil settlement, or disturbance of soil by other utilities, or resting on an obstruction, tests prove that standard 6-inch cast iron pipe in 10-foot span sustains a load of 15,000 lbs.

SHOCK STRENGTH

The toughness of cast iron pipe which enables it to withstand impact and traffic shocks, as well as the hazards in handling, is demonstrated by the Impact Test. While under hydrostatic pressure and the heavy blows from a 50 pound hammer, standard 6-inch cast iron pipe does not crack until the hammer is dropped 6 times *on the same spot* from progressively increased heights of 6 inches.

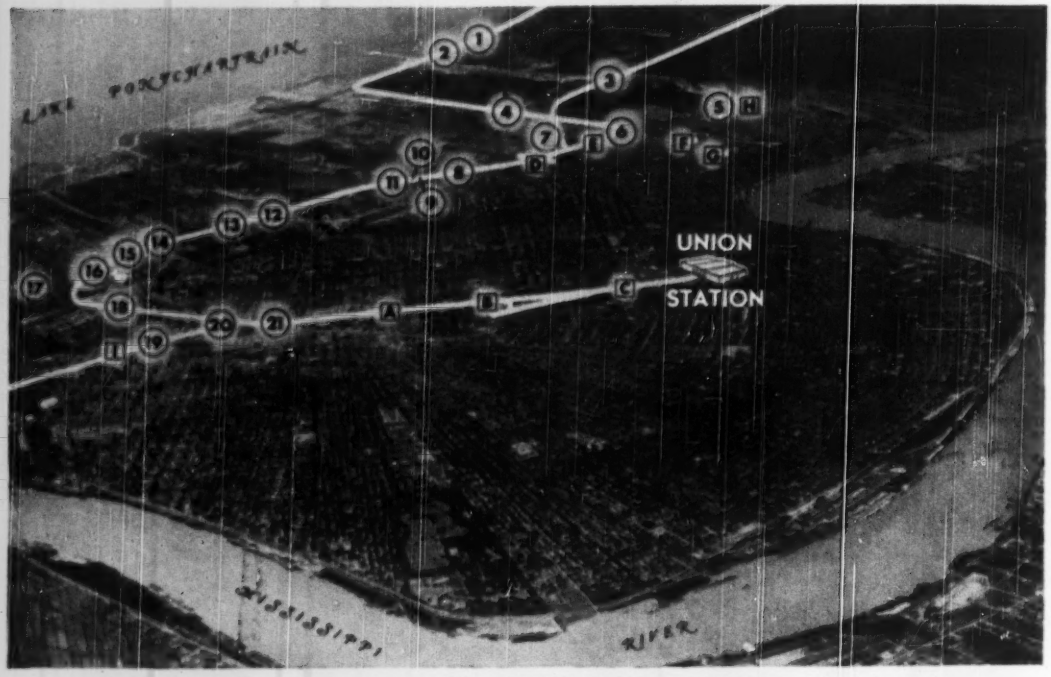
BURSTING STRENGTH

In full length bursting tests standard 6-inch cast iron pipe withstands more than 2500 lbs. per square inch internal hydrostatic pressure, which proves ample ability to resist water-hammer or unusual working pressures.

CAST IRON PIPE RESEARCH ASSOCIATION, THOS. F. WOLFE, MANAGING DIRECTOR, 122 SO. MICHIGAN AVE., CHICAGO 3.

SERVES FOR CENTURIES

THIS NEW
Old New Orleans



Air view of New Orleans, showing location of Union Terminal and 30 grade separations—see key below, right.

$50-Million Terminal and Grade Separation Program Makes Construction History

● Progress is on the march in delightful old New Orleans, where a construction program tremendous in scale and concept is making civic and industrial history:

(1) A great new Union Terminal will shortly replace five scattered, outmoded structures, now serving seven trunk lines.

(2) Thirty modern grade separation structures will eliminate 116 out of 144 traffic-laden grade crossings—22 separation structures scheduled for completion simultaneously with the Terminal, in 1952, then three more within 18 months, and five thereafter.

Soundness of execution matches the imagination and ingenuity of the program. Every project in this vast undertaking embodies the utmost in engineering know-how and in staunch construction of enduring integrity, as exemplified by the use of many thousands of barrels of Lone Star Cement in concrete structures . . . assuring the durability, fire-safety and low maintenance which add up to lowest annual cost and highest taxpayer appreciation.

KEY TO GRADE SEPARATIONS

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OVERPASSES: (A) Jefferson Davis Pkwy., (B) S. Broad, (C) S. Claiborne Ave., (D) Elysian Fields, (E) Franklin Ave., (F) Galvez, (G) N. Claiborne, (H) Poland Ave., (I) Palmetto.

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NOVEMBER 1950
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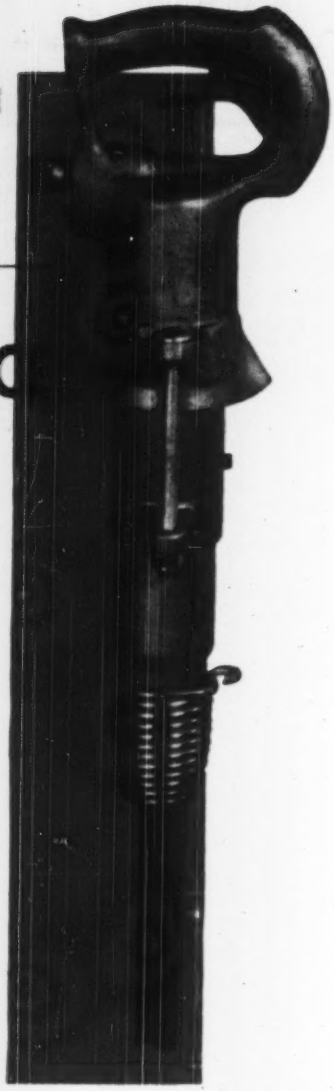

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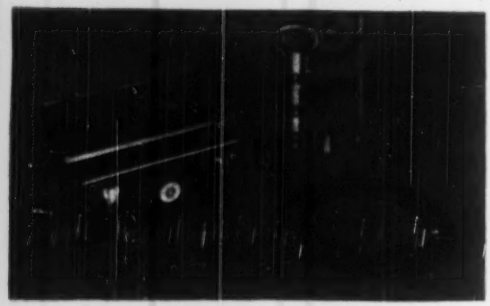

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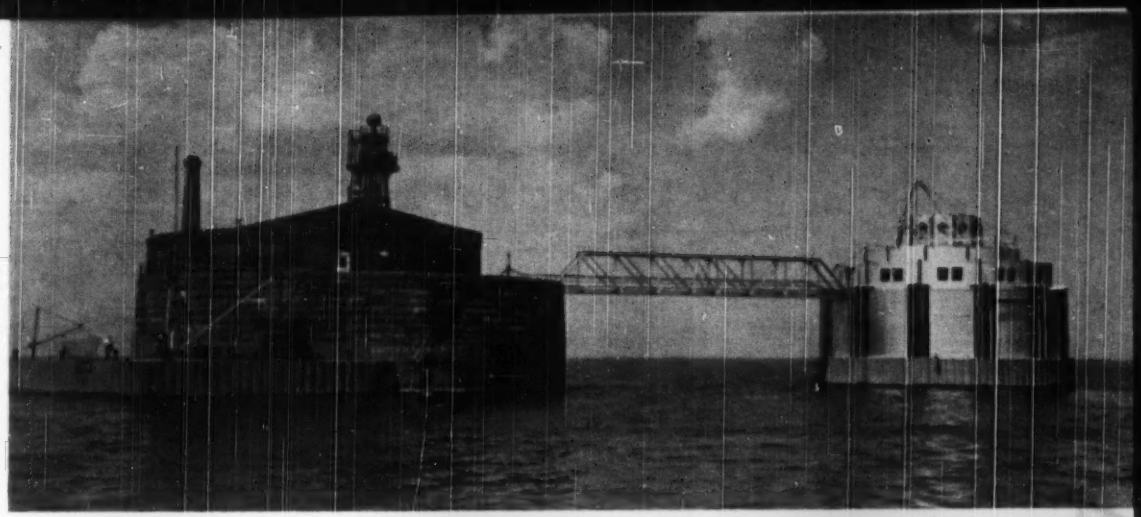


OLD AND NEW CRIBS stand side by side in Lake Michigan about 4 miles offshore. Old Carter H. Harrison Crib (left) provides living quarters for personnel of new William E. Dever Crib (right). Harrison Crib is temporarily out of service until its tunnel is connected into present Chicago Avenue tunnel system, now supplied from Dever Crib intake.

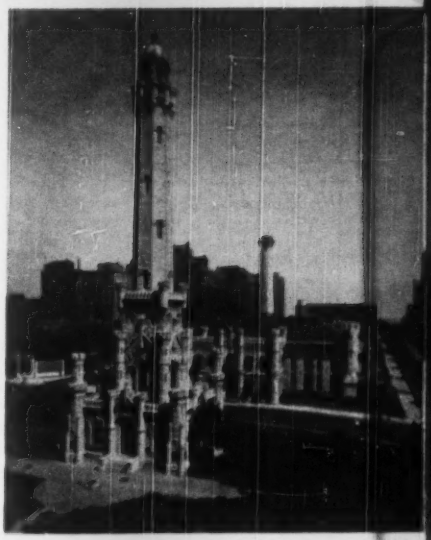
Chicago Water System Serves Growing Population

with

Decreased Pumpage

W. W. DeBERARD, Hon. M. ASCE

City Engineer, City of Chicago, Ill.



OLD CHICAGO WATER TOWER is historic landmark that withstood Great Fire of 1871. It extends into Michigan Avenue opposite pumping station. Younger generation of taxpayers often call for its removal but no official would dare back such a desecration.

CHICAGO'S WATER supply system in 1949 served the largest total population in its history, yet the pumpage was lower than in 1930. The total population served in 1949 was 4,118,119—3,631,835 consumers in the city proper plus 486,284 in 48 suburban communities. The average daily pumpage in 1949 was 972.4 mgd as compared with 1,059.4 mgd in 1930 (the highest of record), when the population served totaled about 3,683,000.

This decrease in pumpage has been achieved in the face of an increased need for water by an energetic program for the elimination of leakage and waste. Weak spots in the distribution system have been reinforced and a vigorous underground leakage survey, instituted in 1932, has been maintained. More recently house-to-house plumbing surveys have covered the city at least once. Also new pumping stations and other facilities have been added from time to time.

The net result has been higher and more uniform pressures over the system and a marked reduction in leakage and waste. The average general pressure in the 1920's was 25 lb, in the 1930's, 34 lb, and today it is 38 lb, up 2 lb from last year. The 1951 goal is 40 lb. The present aim is to maintain at all times at least 25 lb of pressure throughout the system, even on high ground. Records of pressures at 63 locations are reported daily to the City Engineer's office.

Chicago has what is called a direct system of water supply as it takes its water directly from Lake Michigan through intake cribs. Water from the lake enters the inner wells of the cribs through ports in the crib walls, thence passes through gate openings into vertical shafts which connect the cribs with tunnels below the bottom of the lake, and then flows by gravity to suction wells at the pumping stations, whence it is lifted directly into the distribution mains. (See Fig. 1.) Lake Michigan is the storage reservoir.

At present there are four cribs in service—out of a total of six in the system. Two are standbys. Adequate housing facilities are provided at each crib for the men stationed there. The system also includes four separate tunnel systems, 12 pumping stations,

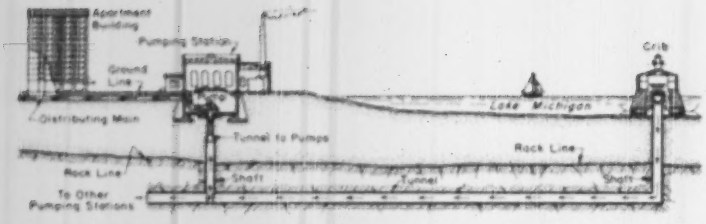


FIG. 1. WATER from Lake Michigan flows by gravity through intake cribs to suction wells, whence pumps lift it directly into distribution mains. Cribs are located from two to four miles from shore in about 35 ft of water.

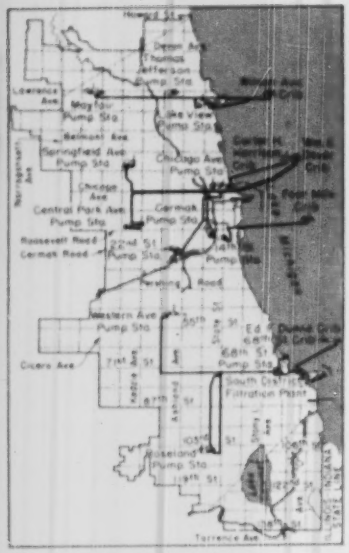


FIG. 2. WATER SUPPLY SYSTEM of Chicago consists of six cribs, twelve pumping stations and four separate tunnel systems. Tunnels range in diameter from 5 to 16 ft, have total length of 63.6 miles and total capacity of 2,060 mgd.

the world's largest filtration plant, 4,000 miles of water pipe from 4 to 54 in. in diameter, 43,000 fire hydrants, 40,000 gate valves, and 120,850 water meters. (See Fig. 2.)

The system is municipally owned and operated and represents one of the largest, and probably one of the oldest business enterprises in the city, its history dating back to 1851, when a private company was taken over and enlarged by the municipality. The water system has always anticipated the rapid increases in population which have occurred since Chicago was incorporated as a town with a few hundred souls in 1833.

Chicago's record-size filtration plant serves about one-third of the city. Its design capacity is 320 mgd and during 1949 it pumped and treated water at an average rate of 307 mgd. The maximum hourly flow from the filtered water reservoir was at the rate of 546 mgd in August 1947.

Of the major pumping systems, seven are steam operated and five are electrically operated. The total rated pumping capacity of all 12 stations is 2,560 mgd. For the year 1949, the total pumpage was 354,912 million gal, of which 59.6 percent was steam pumpage and 40.4 percent electric.

Steam and Electric Costs Compared

Operation of both steam and electric stations makes possible a comparison of the relative costs of the two methods of pumping. Interest and amortization, labor, repairs, and maintenance are generally higher for steam stations than for electric. However, electric power costs materially more than coal, and this difference until recently has been more than sufficient to produce lower operating and maintenance costs for the steam stations. The following summary of operating costs in millions of ft-lb, for the newest of the steam and electric stations, illustrates the closing of the gap between the costs of these two sources of power:

	Western Ave. Steam	Cermak Electric
Operating costs		
1940	$0.040	$0.056
1945	0.048	0.052
1949	0.061	0.051
Repairs and maintenance		
1940	0.005	0.003
1945	0.005	0.003
1949	0.031*	0.003

* Reflects deferred maintenance which could properly be spread over several years.

No exact comparison can be made of the difference in fixed charges for the two stations since local factors such as tunnel connections, elevations, distribution mains, unit construction costs, cost of money, load factor and land values are not comparable. The original cost of the steam station was $4,600,000 and of the electric, $1,340,000. Assuming 5 percent per annum for interest and amortization, the cost per million ft-gal would be:

	Western Ave. Steam	Cermak Electric
Interest and amortization		
1940	$0.035	$0.020
1945	0.036	0.016
1949	0.035	0.015

While the use of two sources of energy for pumping makes for reliability, it certainly does not add to the joys of a city engineer's existence. Watching coal storage melt away during the annual coal strike is not calculated to reduce his blood pressure, although added coal storage, 15,000 tons, is being built up. Gas will probably be put under at least one set of boilers next year.

Chicago's phenomenal growth terminated abruptly with the start of the depression in 1930. The decade from 1930 to 1940 showed little increase in population. Under the influence of war and postwar conditions, a moderate growth of approximately 7 percent took place between 1940 and 1950.

This breathing spell, in what had been a rather desperate race between increase in population and water supply facilities, afforded an opportunity for the Water Department to strengthen its supply and distribution facilities and improve its service and the quality of its water.

Just prior to 1930 two new pumping stations were added to the system. Cermak pumping station and the Chicago Avenue tunnel were placed in operation in 1936, the Des Plaines Street tunnel in 1940, the Stewart Avenue tunnel in 1943, and the South District Filtration Plant in 1947.

In 1932 the Water Pipe Extension Division organized and trained eight field crews to locate and stop underground leakage. The number of crews was increased to 12 in 1934. The total leakage stopped, from 1932 to 1948, was 285 mgd. Distribution of the leakage between various types is as follows:

Joint leaks	34.7 percent
Service pipe leaks	49.3 percent
Broken pipe leaks	3.8 percent
Hydrant leaks	2.5 percent
Valve leaks	1.5 percent
Abandoned pipe leaks	8.2 percent
	100.0 percent

In 1944, a resurvey of 320 miles of mains in the Central District was begun to determine what had happened since the original survey of these same mains. The leakage found was 89,636 gal per day per mile of pipe as compared to the average of 160,443 in the original survey. In the initial survey only 23.3 percent of the mileage tested was found tight while in the resurvey 46.9 percent was tight. It is obvious

that continuous surveys are required to hold leakage in a distribution system to a minimum.

Besides underground leakage, that from plumbing fixtures within private premises was investigated. In 1942 the Water Pipe Extension Division started a house-to-house inspection of plumbing fixtures. It was found that about one out of every ten fixtures examined leaked. Leaky toilets and faucets were found in about equal number. A reinspection of some 5,000 fixtures indicated that the leaks had been repaired in 95 percent of the cases.

The marked effect which this reduction in leakage has had on the total pumpage, and consequently on the operating hydraulics of the system, is indicated by the following comparison between the average daily pumpage and consumption in 1932 and 1949, in million gallons:

Year	Pumpage	Metered Consumption	Non-Metered Consumption
1932	1,009	326	683
1949	972	506	466

Note. Metered services had grown in number from 109,174 in 1932 to 120,850 in 1949, and assessed services had grown in number from 313,469 to 313,702 in the same years.

The increase of 180 mgd in metered consumption between 1932 and 1949 resulted from some increase in metered services but mainly from increased industrial consumption and sales to suburban communities. However, this increase was more than offset by the reduction in non-metered consumption, leakage and waste so that an actual reduction of 37 million gal was effected in the average daily pumpage. In 1932 the non-metered consumption, leakage and waste was 68 percent of the total daily pumpage. In 1949 it had been reduced to 47 percent.

Chicago's present water ordinance requires that all manufacturing, industrial and commercial users, and all residences for four or more families, have water meters, and in general, that all users whose bills amount to $35 or more per annum have meters. Metered users pay a uniform rate of 8 cents per thousand gallons.

Under the Sanitary District Law, the city must, upon demand, supply water to any municipality within the limits of the District when that municipality brings its pipelines to Chicago city limits, at the same price charged to large users within the city. At present Chicago supplies water to 37 such municipalities, some of whom in turn supply water to other outlying municipalities, making a total of 48 municipalities which get Lake Michigan water directly or indirectly from the Chicago system.

In general unmetered users are charged for water under the so-called frontage or assessed rate, a flat rate depending on the lot frontage, size of building and number of outlets. Water is delivered without charge to hospitals, to municipal, religious, educational and charitable institutions, and for parks, fire hydrants, street cleaning and public improvements. Last year water valued at over a million dollars was delivered free to such consumers.

Some general figures on recent pumpage may be of interest. The maximum rate of pumpage occurred August 6, 1947, at 9:00 p.m., when it was 1,734 mgd. The hourly peak was 122 percent of the maximum day and 177 percent of the average day for that year. The maximum day was 144 percent of the average day. The minimum rate of pumpage to date in 1950 was at 5:00 a.m. on Sunday, April 30, when it was 592 mgd. The total pumpage for the year 1949 was 354,912 million gal, of which 24,759, or 7 percent, was delivered to the suburbs. The per capita pumpage for the City of Chicago in 1949 was 246 gal per day, and 140 for the suburbs.

Chicago Has High per Capita Consumption

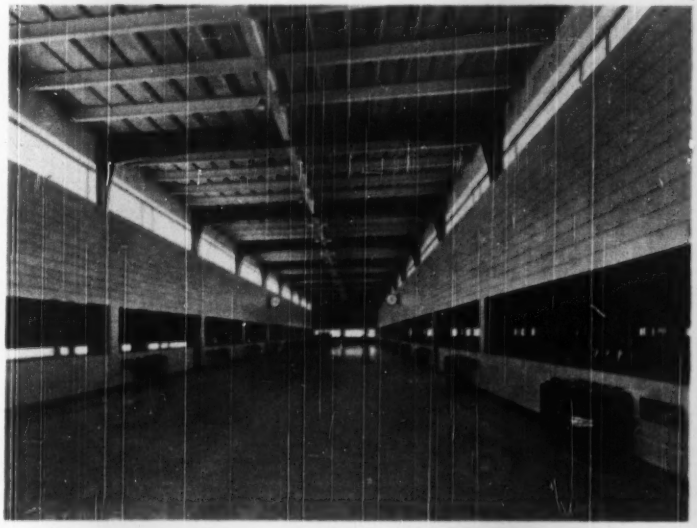
Ever since water works statistics have been assembled, Chicago's high per capita consumption has been a matter of comment, none of it favorable. Although the 1930 per capita daily consumption of 302 gal obviously represented a large amount of waste, it is now apparent that estimates made at that time of the magnitude of this waste failed to take into account factors peculiar to Chicago which combine to produce a normally high legitimate consumption.

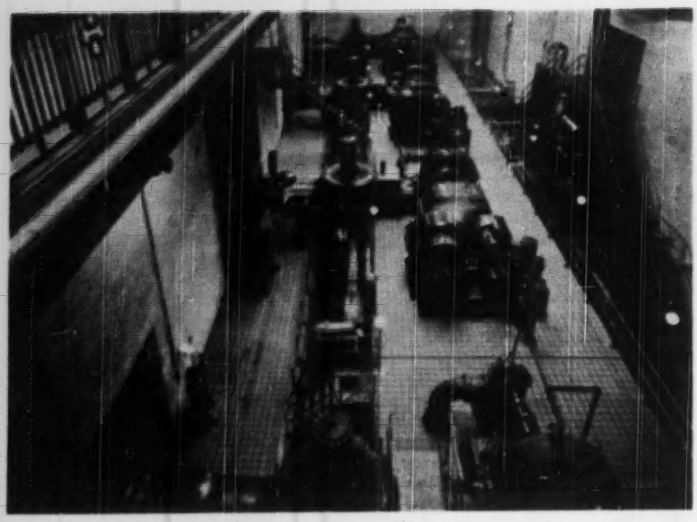
As noted above, in 1949 the per capita daily consumption had been reduced to 246 gal for the city alone, or 234 gal for the city and its suburban customers. Metered consumption for the city and suburbs was equivalent to 122 gal per capita for the entire population. Since only 27.8 percent of the number of the services are metered, it is obvious that when flat-rate per capita consumption is added to the metered consumption and an allowance made for free and unaccounted for water, the total per capita consumption will be higher than the average of other large American cities.

A number of factors produce this legitimate high per capita consumption. They include the industrial character of the city, its railroad demand, its large number of persons per service, and finally its low water rates.

Chicago is a city of diversified industries. One of its largest is the stockyards and packing industry, which use a relatively large amount of water. As it is the railroad center of the United States, the demand for water by this utility is above average. The same reasoning applies to hotels, since Chicago's standing as a con-

SOUTH DISTRICT FILTRATION PLANT supplies water to one-third of Chicago's population. Filter operating gallery shown is one of four in plant, which has capacity of 320 mgd.





FOUR STEAM-turbine-driven 75-mgd centrifugal pumps in Western Avenue Pumping Station vie with electric stations for low-cost honors. This 300-mgd-capacity station was placed in service in 1927.

vention city, which entertains more than 1,000 such groups annually, has resulted in a more than average water demand.

The large number of persons per service results from the character of the housing in Chicago. Much of it is the multiple-unit apartment-house type in which one water service supplies a number of apartments. The number of persons per service is 9.4, compared with an average of 6.2 and a mean figure of 5.8 for other cities of the United States with populations in excess of 500,000.

Most apartment-house tenants use or waste water as best suits their convenience. The cold water faucet is left open to obtain a cool drink. Leaky fixtures are repaired if and when they become troublesome enough to warrant the effort of getting a janitor in. Water is used in lieu of refrigeration in certain of the poorer districts. Hot water faucets are allowed to run until hot water appears. Few plumbing systems are installed with a hot-water return for circulation. Most apartments are of the three-story type which involves many separate risers and long runs to the boiler room.

A simple computation gives the approximate number of family units having no direct interest in the reduction of water waste. In 1945 the total number of water works services in Chicago was 420,397, whereas the total number of electrical consumers served by the Commonwealth Edison Co. was 986,744, according to the Federal Power Commission. Since the electric services of all family units in apartment buildings are metered, the difference between these two figures, or 566,347, represents the families who receive no water bill.

Low Rates Mean High Use

Perhaps the greatest single factor in Chicago's high per capita consumption is its extremely low water rate of 8 cents per 1,000 gal for metered users. For quantities up to 10,000 cu ft per month, it has the lowest rate of any of the 23 cities serving more than 500,000 people. We therefore have in Chicago a condition where industry produces a high per capita water use, usage by railroads and hotels is a maximum, an unusually large segment of the population receives no water bill, and water rates are so low that there is no particular incentive for customers to economize in its use.

Peak demands in Chicago follow the pattern of most water works, with the annual peak either in July or August after several days of extremely hot, dry weather. Chicago has the same air conditioning and sprinkling problems as other cities and one additional problem which it is believed is not so acute elsewhere. It has become a popular practice in Chicago to open fire hydrants on extremely hot days; as many as 500 have been opened in one day. The Water Pipe Extension Division has placarded hydrants, devised special hydrant caps, enlisted the help of the police and secured as much publicity as possible to curb the practice, and it is believed that progress is being made.

Metered consumption for the year 1949, divided between classes of consumers, was as follows, in million gallons daily:

Meter registrations, 3 to 12 in.		
Manufacturing	77	
Outside towns	54	
Packers	33	
Railroads	25	
Office Buildings	20	
Hotels	14	
Laundries	9	
Miscellaneous	56	288
Meter registrations, 2 in. and less		219
Total metered, mgd		507

Peak registrations for manufacturing and the packing industry occurred in 1944. Hotels, outside towns and office buildings registered their peaks in 1948. Railroad consumption has been quite uniform since 1943, while laundries have shown no increase in the past 10 years. The maximum rate of increase in the past ten years occurred in manufacturing, where consumption doubled. Use of water

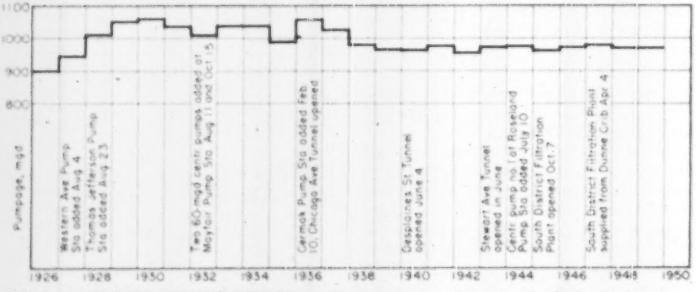


FIG. 3. AVERAGE DAILY PUMPAGE on Chicago system has remained about stationary for past 12 years, despite increase in population and revenue. All-time peak of 1,059.4 mgd occurred in 1930, as compared with 972.4 mgd in 1949. All-time maximum hourly rate was 1,734 mgd on August 6, 1947, at 9 p.m. Maximum day's pumpage of 1,413.87 mgd occurred on same day.

by outside towns was second in rate of increase, and the packing industry third. All these divisions except laundries show marked summer peaks. Laundry consumption is strikingly uniform throughout the year while railroad consumption is irregular, with annual peaks often in January, February, or March. The diesel has had some effect in reducing railroad usage.

Chicago's average daily pumpage, in million gallons, for the year 1949 was 972.4, of which metered consumption constituted 506.7. The remaining 465.7 mgd was divided between assessed rate consumption, leakage, street usage, free water, under-registration of meters, fire department use, flushing and illegal opening of hydrants. The distribution of this latter figure as between assessed rate consumption and other usages is a matter of speculation. Judging from American Water Works Association figures for the percentage of production sold, as reported by eight large, fully metered cities, it is concluded that it would be reasonable to assume a figure of 15 percent of the total pumpage for unaccounted-for water.

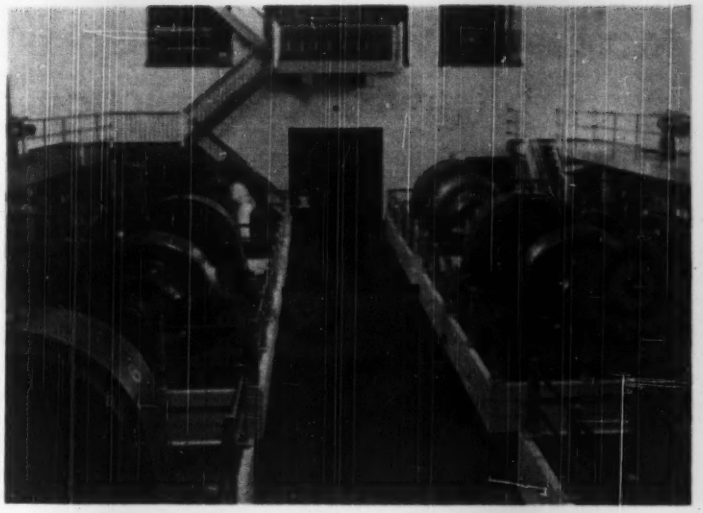
Applying this percentage to Chicago for 1949, 319.8 mgd is obtained as the daily consumption of the assessed rate consumers, an average of 160 gal per day for the estimated 2,000,000 people using water through assessed services. It is estimated that with universal metering this consumption might be reduced to 90 gal per day.

With these data it is now possible to make a rather close estimate of what Chicago's consumption would be with a fully metered system, in mgd:

Present metered consumption	506.7
Estimated consumption of assessed rate services if metered	180.0
Unaccounted-for water (15 percent)	121.2
Total	807.9

This is equivalent to 194 gal per capita daily for Chicago and suburban consumers and 201 gal for Chicago consumers alone. If these estimates are accepted, it must be concluded that Chicago's legitimate consumption is higher than that of any other large city.

Chicago's reputation as a profligate waster of water has been widespread. It is evident that this condition no longer exists. When pumpage today is less than it was twenty years ago, while metered consumption has increased 180 million gal, and non-metered has decreased 217 million gal, it is obvious that there has been a real improvement in the use of water. Our per capita consumption is still high but even with a fully metered system it would exceed that of any other large city.



SIX ELECTRIC-motor-driven 50-mgd pumps at Cermak Pumping Station operate at about same cost as steam stations. This 300-mgd-capacity station was opened in 1936.

All money received by the city from the sale of water, water bonds, or water certificates must by law be placed in a separate fund called the Water Fund. Money from this fund can only be used for operation, maintenance or extension of the water supply system. At present all expenses of the system, including interest on, and retirement of, Water Certificates are paid from water revenue.

The system pays no general taxes but money is appropriated from the Water Fund to reimburse the Corporate Purposes Fund for expense in various city departments common to both Corporate and Water Fund. In 1949, $2,770,000 was taken from the Water Fund to reimburse the Corporate Fund expenses of various departments.

The original cost of the system, as of December 1, 1949, was $220,692,251, a per capita cost of $53.60 based on population served. The cost has been met partly from water revenue, partly from general taxation, and partly from the sale of General Corporate Bonds, Water Loan Bonds, and Water Certificates. The first two types, issued in the earlier years, were corporate obligations and in general the interest and principal were paid from general taxation. The Water Certificates were issued later and interest and principal were paid solely from water revenue. As of December 31, 1949, the bonded indebtedness of the system was $43,900,000 of Water Certificates bearing interest ranging from 5 percent down to 1½. These certificates, which are retired in fixed amounts annually, are highly rated in financial circles.

For the year 1949 revenue was $18,439,105 and operating expenses, $17,535,818 or $4.48 and $4.26 per capita respectively. Operating expense includes reimbursement to other city departments, repairs, and renewals, interest on Water Certificates and judgments.

The Chicago water supply system is under the jurisdiction of the Bureau of Engineering, a subdivision of the Department of Public Works, under Oscar E. Hewitt, Commissioner, who reports directly to Mayor Martin H. Kennelly. The City Engineer heads the Bureau of Engineering. As of 1950 the water supply system has 2,800 employees and a yearly budget appropriation of $26,000,000. This appropriation includes all operating and maintenance costs, as well as capital investments for additions, betterments and extensions.

For the preparation of this paper and assembly of the statistics, credit is hereby given to the various members of the staff, but more particularly to Loran D. Gayton and Fred G. Gordon, Members ASCE, Assistant City Engineers.

(This paper was originally presented by Mr. De Berard before the Sanitary Engineering Division at the Chicago Annual Meeting.)

Increased Maintenance Costs Threaten State Highway Construction Programs

ROBERT H. TITTLE, M. ASCE

Engineer of Construction, Illinois Division of Highways, Urbana, Ill.

HIGHWAY MAINTENANCE costs in the nation have nearly doubled in the past fifteen years, principally because of increased cost of materials, labor and equipment. As a result, these costs are eating up funds that could and should be used for reconstruction and new construction. If the states do not embark on an adequate highway construction and reconstruction program soon, mounting maintenance expenditures will eventually leave very little money available for construction.

Illinois Problem Is Typical

The situation in Illinois is fairly typical of the problem facing highway administrators throughout the nation. Illinois will spend approximately $18,000,000 of state funds for the maintenance of its highway system during 1950, and about $16,000,000 of state and $12,000,000 of federal funds for construction and reconstruction of highways. A recent survey shows that the estimated needs of the Illinois highway system at the end of 1950 equaled the astounding sum of 1½ billion dollars. Some 3,300 miles of roads need resurfacing or complete reconstruction right now.

Maintenance costs in Illinois have increased sharply in the last ten years. The official records show that in 1939 the state maintained 13,933 miles of rural highways and city streets of all types at a cost of $5,986,000. In 1949, the mileage maintained had increased to 14,766 miles, an increase of only 833 miles, but the total maintenance costs, including contract patching, amounted to $17,000,000. These figures do not show that during this same period more than 1,400 miles of concrete pavement were resurfaced with bituminous concrete. Yet the maintenance costs in 1949 were $11,000,000 greater than the maintenance costs for 1939.

The item showing the greatest cost increase is the maintenance of the wearing surface of rural pavements, which jumped from $1,286,000 in 1939 to $7,500,000 in 1949. The principal item contributing to the increase is the repair of concrete pavements. This upward trend of maintenance cost may be expected to continue until reconstruction catches up with needs. Road surfaces, like everything else in continual use, deteriorate with age.

Development started on the hard-road primary system in Illinois in 1919. There was a rush to get traffic out of the mud, and construction progress was rapid. In the one year of 1928, over 1,000 miles of concrete-surfaced roads were built in the state. By 1935, the primary highway system in Illinois was virtually completed. Therefore approximately 36 percent of the primary system is now more than 25 years old.

The roads built during the 1920's were adequately designed to accommodate the passenger cars and light trucks of that period and they stood up well until the early 1940's. During the war years, however, heavy trucks loaded far beyond the weights for which the roads were designed, rapidly shattered the roads.

For over 18 years, through a long depression and a great war, many states, including Illinois, have not been able to keep pace with their highway construction needs. Even badly needed maintenance had to be deferred. As a result, there is a tremendous backlog of highway work to be done, and available funds are insufficient. Most highway departments are fighting a losing battle in their efforts to keep the roads in some sort of passable condition.

Costs Have Doubled for Most Items

A comparison of maintenance costs for other than wearing surfaces, between the years 1939 and 1949 shows that costs have about doubled for most items because of rising prices. For instance, maintenance records for Illinois show a gradual increase in the cost of such items as weed cutting, highway signs, and maintenance of earth shoulders, ditches, and roadside planting. Depending on weather conditions, the cost of snow removal and ice control fluctuates widely from year to year, but the average annual cost has been creeping upward. This increase can be attributed to improved service required by traffic, increased cost of labor, materials, and equipment, diligence in removing snow and ice, and the increased use of cinders and salts. The safety and freedom of movement given to the traveling public during bad weather conditions justifies these additional costs.

Improved Design Cuts Maintenance

The engineer is always striving to improve the design features of new roads, and the reconstruction of old roads, in order to reduce maintenance costs. Improvements such as raised grade lines on modern roads cut down the amount of snow to be removed and also reduce deterioration resulting from pavements which are placed close to a high water table. Flatter slopes in cuts and fills, seeding, and sodding reduce erosion. Study now given to subgrade soils and the use of granular subbase materials should reduce future road failures.

It is expected that maintenance costs will continue to increase unless the rate of reconstruction of worn-out sections equals or exceeds the rate of pavement failure. At present, the funds available for highway purposes in Illinois are too small to maintain the necessary reconstruction rate. Unless additional income is provided, maintenance demands may absorb practically all the present income for highway purposes.

Delayed construction and reconstruction not only entails excessive and skyrocketing maintenance costs for the state, but also increased operating costs for the motorist. The cost of automobile repairs, and time wasted by traffic delays, not to mention injuries and deaths due to inadequate and obsolete highway facilities, all add up to far more than the cost of supporting an adequate highway system. The economy of the state and the nation is in a large measure dependent on motor vehicle transportation. We cannot afford a highway system that is structurally and functionally obsolete.

(This article is based on the paper presented by Mr. Tittle before the Highway Division at the Chicago Annual Meeting of ASCE.)

Chicago Extends Subway Under La Salle Street Station

DICK VAN GORP, M. ASCE

Chief Subway Engineer, Department of Subways and Superhighways, Chicago, Ill.

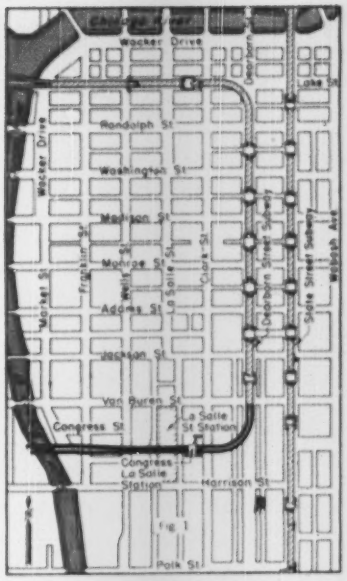


FIG. 1

DURING the construction of Chicago's second subway route in the Loop District, which is now approaching completion, many unusual engineering problems were encountered on account of the nature of the subsoil through which tunneling operations were conducted, and because of the proximity of large buildings. The most difficult problems were encountered in tunneling under compressed air on the last section to be built, which extends under Congress Street from Dearborn Street to the west bank of the South Branch of the Chicago River (Fig. 1). In this section the subway passes under the La Salle Street Railroad Station.

The train-shed trackage in the station was built on spread footings which support the eleven tracks of the New York Central and the Chicago Rock Island and Pacific Railroads. Some of the trains using the station are the Golden State Limited, the several Rock Island Rockets of the Chicago Rock Island and Pacific Railroad, and the Twentieth Century Limited and the Commodore Vanderbilt of the New York Central System. The trains enter the station on tracks located 15 ft above the existing street level, and the subway arch is approximately 35 ft below the street level, as shown in Fig. 2.

The footings that support the track structure are 20 ft above the tunnel arch. Before tunneling could proceed underneath the station the existing columns of the train shed and track structure were shored up to insure uninterrupted train operation.

La Salle Street Station is a 45-year-old structure of steel and masonry, with train-shed walls supported on pile foundations. The roof trusses, two spans in length, are supported on the exterior walls of the train shed and on a row of columns at the train-shed center line. These columns rest on caissons which extend through 70 ft of blue clay to a hard clay stratum capable of carrying the load.

The street-level floor is used by the railroad companies principally for mail, baggage, and express handling. The second floor is at the track level, and is used for passenger loading. Spread footings forming the foundations of the track structure carry the track loads, and are of the conventional stepped type built in the early 1900's. The track-structure foundations are located under the center line of each track and are spaced 15 ft and 30 ft center to center longitudinally in the respective halves of the station.

In advance of driving the tunnel under the station, temporary supports were provided for 85 columns supporting tracks and building, and permanent caissons were built under 26 columns, of which 22 support tracks and 4 support building walls. The permanent work also anticipated later construction for the passage of half of the West Route Superhighway through the railroad station. Under 54 of the columns screw jacks were in-

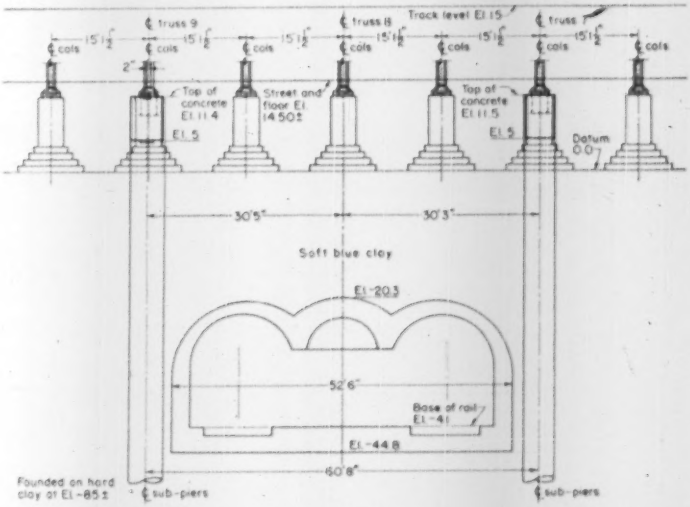


FIG. 2. COLUMNS of La Salle Street Station, 54 in all, were supported on jacks to compensate for settlement during tunneling of subway under station's 11 tracks. Permanent caissons, extending through 70 ft of soft clay to hard stratum, support 26 of the columns.

serted, generally 24 jacks to a column, depending on the load to be carried. Each jack was figured to be loaded at 10 tons. The screw jacks were set on 12-in. I-beams supported on the concrete piers placed on the original concrete footings. These jacks were inserted to lift the train shed and tracks and keep them up to grade as the clay soil under the footings settled during the tunnel driving for the subway. During the period of tunneling directly under the station, a series of 6 to 10 level readings were taken on each column footing during each 8-hour shift.

TRACKS IN SUBWAY TUNNEL are 55 ft below street level. Tunnel extends across street in immediate foreground and under La Salle Street Station at left.

Both subway tubes lie directly under the railroad station columns in the west half of the station. However, the severest settlement took place over the north tube, which was the first mined, and before tunneling procedures were modified as described later. At one time it reached 20 in. in 24 hours, but the subcontractor in charge of the shoring, Gooder-Henrichsen Co., allowed only $\frac{1}{4}$ in. of actual settlement to take place throughout the entire tunneling and concreting operations on the subway. After completion of the tunnel, readings were taken and compensating jacking was continued until the records showed no settlement for a 60-day period. Then the column bases were reset, new concrete bases were poured, the columns were fastened to the bases, and all shoring brackets and jacks were removed. The caisson work started in August 1947. All caissons and cap girders were completed in April 1948 in advance of the tunneling.

Hand Mining Through Soft Clay

Tunneling of the station section of the subway was done in three stages. Soft blue clay with a water content of 25 percent was encountered in most of this section. First, the north tube was cut through the railroad station property, then the south tube, and finally the center arch was excavated. In this section the bench mining method was used. It is best suited for use when tubes are shaped like a horseshoe as in this case. Excavation was advanced on a series of benches and the bracing was placed immediately after the clay was cut out.

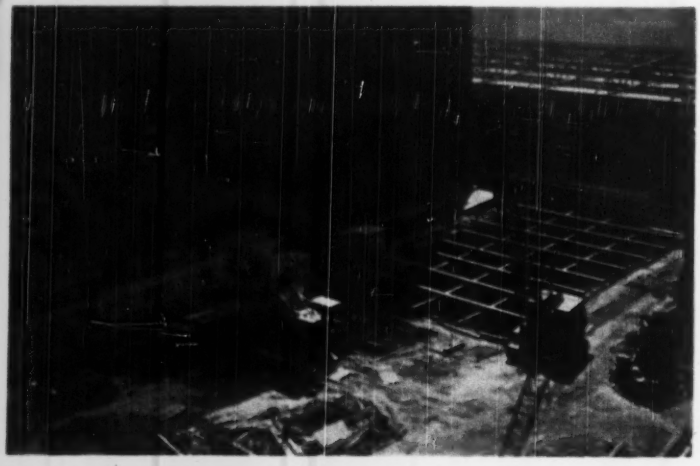
The clay was excavated with power knives, hand knives and air spades, depending on its consistency, but most of it was cut out by power knives pulled by cables activated by air hoists. The first step in the excavating procedure was to advance a small "monkey drift" ahead of the crown mining face on each side of the main tube at the springing line of the arch. An 8-in. H-beam, called a wall beam, with its web horizontal, was set on wood foot blocks resting on the clay in each "monkey drift." These beams were usually in 12-ft sections, except on curves where the length was varied to fit the curve.

The crown face was excavated for a distance equal to the width of a liner plate, usually about 30 in. Two 6-in. I-beams, bent to form a transverse rib, were set to bear on the web of the wall beams and were joined and bolted at the crown. Between these transverse ribs, steel liner plates were set to bear on the back flange of the rib.

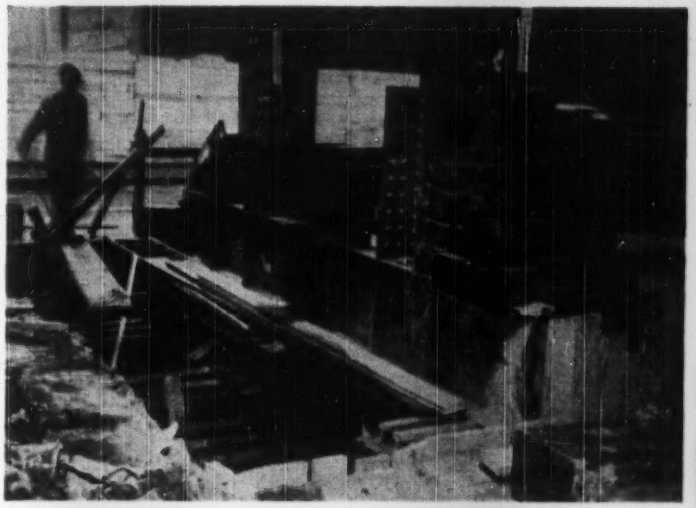
Excavation for the crown face was advanced in these 30-in. steps for about 12 ft, with the steel arch lining closely following, before the sides and middle face were excavated. A vertical cut was then made along each side of the tube down to the bottom of the section, and steel side posts resting on a hardwood grillage were placed under the wall beam at 30-in. intervals to support the arch lining. Jacks, placed on these grillages, jacked up the wall beams before the steel side posts were placed. Next, steel liner plates were placed between these posts to support the sides of the excavation. After the side posts were in place, the middle bench, and then the bottom block, was taken out.

Squeeze Deformed Tunnel Ribs

Fortunately the soft plastic material changed to a stiffer clay at the depth of the invert of the tunnel, where the rib footings were located. The heavy live loads on the station columns, some of which carried as much as 450,000 lb, and the loads induced by the jacking operations caused pressures much greater than ordinary to bear against the steel liner plates and ribs supporting the tunnel excavation. For instance, in



CONSTRUCTION OF Congress-La Salle Street subway station and crossover structure proceeds in open cut. Railroad train shed appears at upper right.



SETTLEMENT OF TRAIN-SHED COLUMNS was controlled night and day for three months during tunneling by supporting each column on twenty-four jacks. Level readings on scale attached to columns recorded settlement. Ground under one column settled as much as 20 in. in 24 hours but jacks maintained building and tracks at original grade.

the west-bound tube the load became so great on August 4, 1949, that the arch ribs and wall beam settled and deformed in the tubes.

On this occasion tunneling was immediately stopped, additional bracing installed, and the lower benches mined at once so that the concrete invert of the tube could be poured close to the mining face, incorporating the steel legs and thereby spreading their load over a greater area of soil bearing. After the invert was concreted and additional supports provided, the arches were reexcavated to proper dimensions and concreted before further tunneling was undertaken. A squeeze of this nature affected an area of approximately 12 lin ft of excavated tunnel.

After two of these squeezes, a new mining procedure was set up as follows: The length of the first or upper bench was kept to approximately 8 ft; legs supporting the wall beams were placed within 4 ft of the heading face instead of the usual 12 ft; and jacks and posts were used on the top mining bench to support arch ribs, and to spread some of the wall-beam load over the upper bench.

In the two locations where the greatest squeeze occurred, the inward movement of clay at the face appeared to be normal during tunneling, but the concentrated vertical pressures from the jacking of the station columns were extremely heavy. This concentration came directly over the center of the ribs in the tunnel.

Lining Placed and Pressure Grouted

As soon as a sufficient length was tunneled to allow a 20-ft arch pour, forms were moved into place. Concreting operations were carried on with the pouring of a length of arch and invert in one of the two operating headings each day. A central mixing plant consisting of a dual drum Ransome 34-E paver; and a Model 200 Rex Pumpcrete machine set up at street level, were used for mixing and placing all concrete. Concrete materials were dry batched in trucks containing three batches of $1^1/_4$ cu yd.

Wet grouting behind concrete followed the arch pours closely. A central mixing plant consisting of a mechanical mortar mixer with a reciprocal-action pump was set up in the tunnel. From this location grout was pumped through a $1^1/_2$-in. pipe to the desired locations. Pressures varied from 25 to 250 psi.

Hazardous Work Successfully Completed Without Interrupting Train Service

Because of the soft clay and the concentration of heavy loads, there was an unusual amount of ground settlement, but it was a thrilling experience to have a part in the construction work which was so conducted that the people arriving on the Twentieth Century need have no fear (and indeed had no knowledge) of the hazardous work that was being done 50 ft below the train.

The job was successfully completed, but it was one which required round-the-clock supervision for more than three months by three shifts of men. Vigilance was necessary to note and record settlement and to provide jack crews to compensate for whatever settlement was recorded. Extremely careful and detailed planning was required and close scheduling of contract operations involving the allocation of working areas for the contractor. Such space allocation was necessary to avoid interference with the many hundreds of baggage and mail-truck movements that had to go on each day for normal station operation.

The work was carried out under the direction of the Department of Subways and Superhighways of the City of Chicago. Financing was from local traction funds of the city and funds received as a grant from the U. S. Public Works Administration. The general contractor on this subway is the S. A. Healy Co. and Peter Kiewit Sons' Co.

TWIN SUBWAY TUBES were hand excavated under compressed air. View of east end of completed tubes under La Salle Street Railroad Station shows crossover at end of subway station.

(This article is based on a paper presented by the author before the Construction Division at the Chicago Annual Meeting of the Society.)

You Can't Buy National Defense

J. F. JELLEY, M. ASCE

Rear Admiral, CEC, USN, Chief of Bureau of Yards and Docks, Washington, D.C.

NATIONAL SECURITY cannot be bought. Too often the most impressive fact about government work is the number of digits after the dollar sign. This cost has ruffled the fur of our critics and smoothed the complacency of our friends. We are criticized for extravagance on the one hand while on the other it is assumed that we can provide complete military defenses by simply spending money.

Neither fiscal appropriations nor credit will buy an adequate defense. We can buy lumber and bulldozers. We can hire engineers and mechanics. And certainly without such expenditures, this nation's technical capacity and know-how will be lacking the necessary tools. However, materials and services that must be purchased are not enough. Security can be achieved only by the effective employment of our defense capacity from all sources. We cannot match the manpower of the Communistic world in numbers. We must surpass it by utilizing the quality of our manpower. We must make the most effective use of what human skills and abilities we have. It is difficult to put a price tag on man's skill and ability. It is a commodity that cannot be budgeted and appropriated for by Congress.

Instead of quibbling about how much of our productive effort can be expended, the problem becomes one of how much of our natural resources can be mined and milled and processed, and how much brain and muscle and sweat we can muster. The dollar sign then becomes a yardstick which measures the degree of the effort. Our problem becomes the basic one of what we can do to protect our country and our way of life. This cannot be solved by an appropriation bill, as the French found out in 1940 when the German war machine raced across their country. They were victims of the belief that defense is entirely a physical thing which can be constructed and manned by the military alone while the rest of the nation carries on business as usual. They believed that national security could be purchased, delegated and then forgotten.

Do-or-Die Patriotism Not Enough

If the chips were down, civil engineers would produce. They would, without the slightest doubt, contribute freely of their time, training and ability, and even their lives to the country's defense. Unfortunately, an adequate defense cannot await the dramatic moment when the chips go down. Do-or-die patriotism, confronted with a modern war machine, is likely to produce very little "do" and a whole lot of "die."

It is the nature of most engineers to leave public business to others—particularly to those who work with the tools of words and emotions. And this lack of concern develops into a deep-grained habit, with the result that engineers are all too likely to become mere spectators of political decisions. But some of these popular decisions must not be ignored. It is time to abandon a passive attitude and recognize that civil engineers must be more deeply concerned with national defense.

Certainly few professions in America are better qualified by training to contribute to the solution of the defense problem. We are accustomed to defining the problem, to getting and checking the facts which relate to it and investigating to obtain the best solution. This method of analysis and solution can be used for many of the non-engineering problems which confront us. As a matter of fact, engineers have proved that they can successfully handle many non-engineering military billets because of this basic training.

What Can ASCE Do?

How can we give the Armed Services the benefit of our professional knowledge? How can the ideas and talents of the engineering profession be utilized to the fullest? How can our Society do its part in the defense of our country?

ADMIRAL JELLEY addresses Chicago Annual Meeting of ASCE. Address is presented here in somewhat shortened form.

Our Society should set up a military liaison group consisting of the leaders of the profession and representatives of the military services. This group should mobilize and direct the wealth of talent available on our Technical Division committees. These technical committees have made many outstanding contributions to the profession and they could do the same for national defense. If the technical committees had a more detailed knowledge of the needs of the military they could evaluate the work they are now doing to determine if any part of it is of military value. They could initiate new programs.

Such a liaison group would fill a most important gap and would be accorded a maximum of cooperation from the Armed Services, which would welcome an opportunity to utilize the latent talents of the profession.

Here are a few examples of the engineering problems that the Civil Engineer Corps of the Navy is trying to solve in carrying out the mission of the Bureau of Yards and Docks. Our goal is to provide adequate shore support for the fleet with a minimum amount of equipment and material and with as few men as possible. We are trying to develop mobility in this shore support. We are designing facilities that can be assembled or built in the shortest possible time.

We are developing and improving methods of getting men, equipment and material from ship to shore under every possible condition, and finally, we are investigating materials that will stand greater ranges of temperature and extreme hard usage.

We are trying to develop at reasonable cost an airfield pavement that will take the terrific pounding of the newest planes. The speed of jet planes, the high pressure of their tires, and the heat of their exhaust are too much for conventional runways.

We also are trying to build up a wealth of information on the use of substitute materials. We know from experience that it will be necessary to ration many of the basic materials of construction. We must have alternate materials ready if shortages develop in conventional materials. This general problem has led us to investigate prestressed concrete, use of precast concrete in thin sections, use of welded steel and thin-walled steel shapes.

Another group of engineering problems arises from the need of getting equipment and material from ship to shore. How can we stabilize sand beaches and marshland quickly in support of an amphibious landing? Soil stabilization may give us the answer. Perhaps landing mats could be used. Conveyor-belt systems and ship-to-shore cableways have possibilities. Experiments have been made on all these methods but have not produced fully satisfactory answers.

In anticipation of putting a damaged port back into operation, we already have developed a lightweight diesel pile hammer. This is quite a piece of equipment—no boiler plant or air compressor is required because the power mechanism is contained in the hammer itself. It has important commercial possibilities.

Perhaps the answer to the port problem lies in the use of mobile harbors, such as the ones towed across the English channel for the Normandy invasion. A good many ideas along this line are being investigated.

Nor do our research problems end with getting material to the site of an advance base. The challenge is for equipment that weighs less but can be assembled faster or operated longer at high speeds. If it can be transported by air, so much the better. Already we have developed a very useful light-weight motor grader. It has a six-wheel drive and develops more pull at the blade with a 76-hp engine than the conventional type with 100 hp, yet it weighs 5,000 lb less.

Still another major field of study concerns climatic conditions. We must be prepared to build anything the Navy may need ashore, anywhere in the world, including the far North. For oil exploration work in the Navy Petroleum Reserve at Point Barrow, we have developed a prefab Arctic hut that meets all but one very important requirement. It is well insulated, easily heated, easy to transport and to assemble, but it costs too much.

The capacity of our engineering minds—our abilities to apply an engineering approach to our problems—is too valuable an asset to be dissipated. The engineering profession must mobilize itself. This is a patriotic privilege—the privilege of contributing initiative as well as knowledge.

Can We Design for Atomic Blasts?

ARSHAM AMIRIKIAN, M. ASCE
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POSSIBILITY OF atomic warfare has made everyone protection conscious. Now that the initial shock caused by the threat of this new weapon has passed, it is possible to give at least a qualified reply of assurance to the inevitable question, "Can we provide protection?" The answer can be summarized as follows:

1. No complete or unqualified structural protection against the A-bomb, as well as some of the conventional bombs, is feasible.

2. Within the critical range of explosion, all buildings, regardless of type of framing, will suffer damage, varying in severity in accordance with their proximity to ground zero.

3. In general, the design criteria for protection against an atomic bomb of the presently known type are not as severe as those required for some of the conventional weapons of the last war. Assuming that the bomb is to explode at an altitude corresponding to the maximum range of damage, the changes to be introduced in conventional designs of reinforced concrete for the needed protection will be relatively small.

4. By properly arranging the framing and details of a structure, sufficient over-all strength can be provided to avert collapse, even though severe local damage may occur in the form of large plastic deformations or failures.

5. With certain assumptions of probable structural behavior, the over-all strength of a framing and the extent of damage to local members can be satisfactorily ascertained.

Stock Phrases Give Wrong Impression

Statements regarding construction of protective structures often convey wrong impressions of strength and structural adequacy. This is due mainly to improper or unqualified use of such stock phrases as "bomb-proof," "atomic-proof," "blast-proof," and "splinter-proof."

To designate a building or a structure as proof against a weapon, without completely qualifying the physical and ballistic properties, as well as the range and orientation of the weapon, is meaningless. Even with such qualifications, no true appraisal can be made of the obtainable protection without a change in our conventional concept and understanding of strength and resistance.

Unlike conventional design, the extent of damage due to a weapon's loading on a protective construction cannot be fully or clearly anticipated or determined. Only rarely are conventional structures greatly overloaded. In contrast, protective structures might be greatly overloaded because there is no control over the weapon loading which may be imposed. There is no assurance, except that given by the laws of probability, that the assumed conditions and severity of loading will prevail and the damage may be far beyond the range conceived in the design. As a practical corollary, we may have to assume that a building will suffer maximum damage, which may be taken as a condition short of collapse of local or individual members of framing. The analysis of the strength of a structure under atomic blast presented here is predicated on this concept of structural behavior. It may be considered as a limit design where local use is made

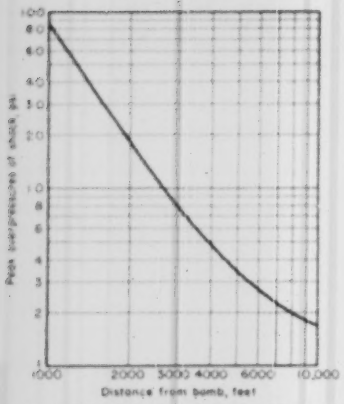


FIG. 1. INTENSITY OF PEAK PRESSURES in shock front decreases with propagation of shock wave

of the full dynamic resistance of members under relatively large plastic deformations. However, such local overstresses, or even some failures, may not necessarily mean a serious impairment of over-all structural adequacy, since in most cases, by proper arrangement of framing, the needed strength and stability of the structure as a whole may still be retained.

For purposes of structural analysis, weapons of modern warfare may be placed in two general categories: (1) Those that cause greatest damage by the impact of their penetrating mass, and (2) those that cause greatest damage by the blast of the explosive mass.

The first category, which may be referred to as weapons of impact, includes projectiles fired from guns, conventional bombs having a charge-to-weight ratio smaller than 20 percent, rocket-assisted bombs, and guided missiles. The second category, referred to as weapons of blast, includes atomic bombs and high-explosive or conventional bombs having a charge-to-weight ratio higher than 20 percent. In general, weapons of impact cause severe damage locally, while the effect of weapons of blast is characterized by over-all damage of relatively less severity.

The development of the atomic bomb introduced a new criterion in the design of structures for protection against weapons in the second of these categories. The efficiency and destructive power of this new weapon is now vividly illustrated by a comparison of its energy of fission to that resulting from conventional explosives. An atomic bomb of the type dropped in Japan is equivalent to 20,000 tons of TNT. Hence this bomb, which serves as a basis for establishing a design loading for blast, is referred to as a 20-kilo-ton bomb.

The destructive effects of atomic fission are caused by the shock wave and the thermal and nuclear radiations associated with the phenomenon. From the point of view of structural adequacy, resistance to the shock wave constitutes the primary problem in protective construction.

A shock wave is essentially a pressure wave initiated by the energy released during an explosion. The general pattern of the pressure wave is characterized by a shock front, where the intensity of pressure sharply rises from atmospheric to a maximum or peak value, followed first by a positive and then by a negative phase. The intensities of the pressures and their durations decrease with the propagation of the shock wave. Similarly, the velocity of the shock front decreases from an indeterminate maximum near the center of the explosion to the velocity of sound at a distance of about 10,000

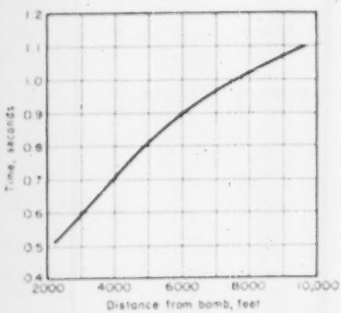


FIG. 2. DURATION of positive phase of shock wave varies in proportion to distance from center of explosion

ft. For design purposes, the velocity of the shock wave may be considered as constant and equal to 1,400 ft per sec from 2,000 to 10,000 ft from the center of the explosion. The variations in peak pressures in this range corresponding to a 20-kilo-ton bomb, are shown in Fig. 1. Durations of the positive phase are given in Fig. 2.

The analysis of a structure under blast involves two main investigations, strength and stability. The strength computation may be divided into local strength, resistance of individual members, and over-all strength of framing or assembly. The investigation of stability includes a study for stability against sliding and against rotation or overturning.

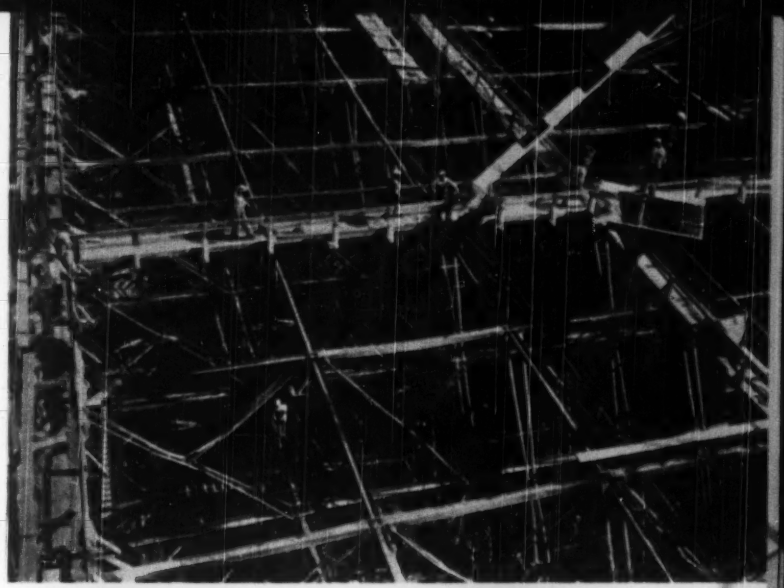
To ascertain the strength of a framing arrangement, the strength of each individual member must be considered. Assuming that the member will have adequate supports for transfer of its load, the problem becomes a study of anticipated deformations of the member relative to its supports. Under an impulse loading, the strength behavior of the member, or its capacity to absorb an impulse loading, will be governed in large measure by its ductility. The larger the deformation or the axial elongation and the corresponding sag or deflection, the greater the capacity to absorb the imposed loading. The ductility of a reinforced concrete member to produce desired deformations for resistance is governed by the ductility of its reinforcement.

When a reinforced concrete member is subjected to an impulse loading many times greater than its elastic resistance, the concrete will crack extensively and the reinforcement will elongate plastically, developing hinges at the supports. As a result, the ends will rotate, the inflection points of the deflection curve will move nearer the supports, and the deflection curve will approach a simple parabola. Failure will generally occur by tensile rupture of the reinforcement.

If a factor is applied against the maximum deflection to prevent such failure, then the resulting deformation may be considered as a limiting condition in obtaining a practical or working resistance in design. This deformation may be stated in terms of axial elongation, or of unit strain. Assuming that the reinforcement will elongate uniformly, the unit strain can be obtained by dividing the total elongation of the reinforcement by the over-all length of the member. A maximum deflection of one-tenth of the span is suggested as a limiting value. This corresponds to an average elongation of 2.8 percent.

In conclusion, it should be remembered that protective design, as a measure of defense, can only follow the progress of weapons of offense in a vicious circle of continued improvement. For what is devised to be adequate against the weapons of today may easily be inadequate against the weapons of tomorrow. This reflection should serve as a sobering influence, preventing the creation of a false sense of security.

(This is an abstract of the paper presented before the Structural Division at the Chicago Annual Meeting.)



EAST ANCHORAGE COFFERDAM of Delaware Memorial Bridge is dewatered after placing of tremie seal. Placing of cofferdam seal of almost 27,000 cu yd in 7.4 days was record for uninterrupted concreting.

Records Broken in Building Anchorage Piers for Delaware Memorial Bridge

Mammoth Tremie Seal Poured in 7½-Day Continuous Operation

CARL H. COTTER, M. ASCE

President, Merritt-Chapman & Scott Corp., New York, N.Y.

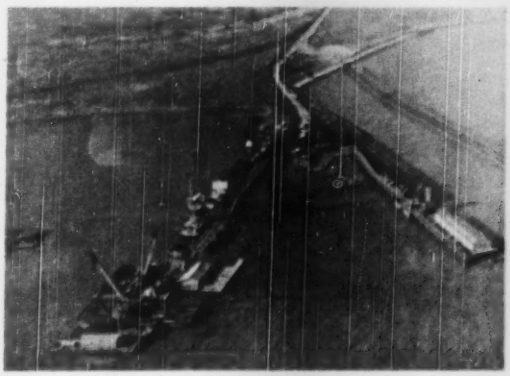
TWO DISTINCTIVE features of the $40,000,000 Delaware Memorial Bridge now under construction south of Wilmington, Del., will never be seen by motorists who cross the four-lane span, 3½ miles long including approaches, en route between Delaware's duPont Highway and the New Jersey Turnpike. Nor will they be seen by those passing by boat under the clear central span of 2,150 ft. Both these distinctive features relate to the foundations of the two anchorages which are out of sight at the river bottom. One is the 60-well caisson for the west anchorage pier, 95x221 ft, the largest in area ever built. The other is the tremie seal for the east anchorage pier, a solid block of concrete 99x225x32 ft deep, which was poured in a total elapsed time of 177½ hours.

Merritt-Chapman & Scott Corporation's part in this, the world's sixth longest suspension span (CIVIL ENGINEERING, November 1949, p. 40), called for construction of both anchorage piers, the two tower piers, and six approach piers, four on the west side and two on the east. The first step was to establish a base of operations and work schedules which would cause the least possible interruption to shipping and at the same time speed construction.

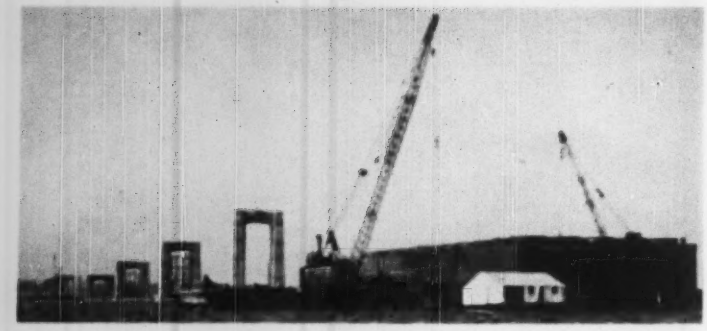
The base was built at Pidgeon Point, about a half mile north of the bridge site on the Delaware side. It served both as a supply depot and service station for the task force of more than 50 pieces of floating equipment which eventually converged on the project. As part of the base, a new 600-ft pier was built and equipped with three sets of railroad tracks tied in with the Reading Railroad terminal. Pierside storage facilities were built to handle bulk shipments. Conveyor systems were rigged to transship the bulk cement to covered barges. During peak operation, cement was used at the rate of 20 carloads per day. Machinery, metal working and carpentry shops were set up and fully equipped.

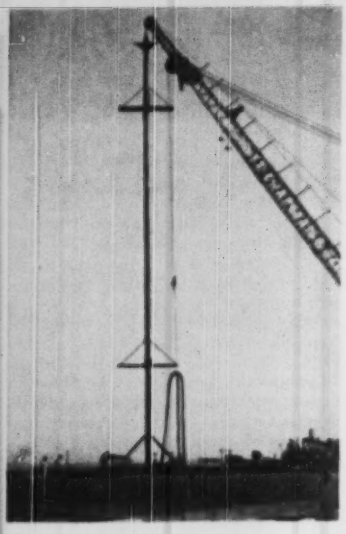
Fresh water was a problem and a special well with pump and piping facilities had to be installed to insure the supply of 158,000 gal per day needed for concrete mixing and other operations.

Coordination of these advance preparations and of the actual construction that followed was handled from a floating headquarters that served as a field office from start to finish of the project. The 150-ft



CONSTRUCTION BASE at Pidgeon Point serves as supply point, service depot, and floating headquarters throughout project. Base also serves as control center for two-way, short-wave, radio net which permits project manager to control every key piece of floating equipment at all times.





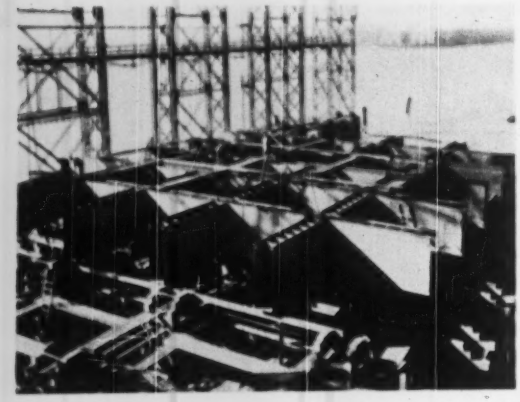
WEST ANCHORAGE CAISSON (foreground) is erected to 68.5 ft above cutting edge. Contract for river work, awarded to Merritt-Chapman & Scott, included two anchorage piers, two tower piers, and six approach piers.

HIGH-PRESSURE rotary water-jet is lowered into caisson to loosen hard-packed clay at river bottom and permit sinking of caisson to designed depth. Horizontal struts projecting at intervals from side of pipe keep jet centered in caisson well.

barge on which the headquarters was built, provided office space and facilities for supervisory, accounting, payroll and purchasing departments and a completely equipped field hospital. Telephone switchboards and power systems were hooked into the nearest outlets. Most important, the floating headquarters also served as control center for a two-way, short-wave radio network which permitted the job project manager and his assistants to keep in touch with every key piece of floating equipment on the river at every hour of the day and night. Constant and complete communications are imperative on a project such as this, particularly during concreting.

Every phase of the river work entailed its own interesting problems, but those encountered in constructing the six approach piers were comparatively routine as compared with those posed by the two anchorages.

The west anchorage pier, like the approach piers, was built by the open-dredged-caisson method. The size of the caisson, with 60 wells 15 ft in diameter, arranged in 5 rows of 12



TRANSVERSE GIRDERS for west achorage caisson are built on shipways in Camden, N. J. After launching and before being towed to pier site, sides were built to height of 34½ ft.

wells each, created special problems of off-site construction and on-site mooring and placement.

The cutting edge, 13 ft high with outside box-girder walls 4 ft thick and inside stiffening box-girder diaphragms 2 ft 9 in. thick, was built on shipways at the Camden, N. J., yard of the New York Shipbuilding Corp. Launched from shipways, the cutting edge was then towed to a pier at Philadelphia where its sides were built up 34½ ft. From there it was moved by tugboat down the Delaware to the bridge site.

Positioning difficulties were expected because the 221-ft caisson had to be sunk broadside to the Delaware's tidal currents. Therefore, before the caisson arrived, four 30-ft-dia sand islands were built, two upstream of the site and two downstream. On the shore side of the rectangle formed by the four sand islands, two steel-pile dolphins were driven. The caisson was shunted into this three-sided guide pen at slack tide and locked in position by driving two more dolphins on the channel side of the site. Fender systems built inside the pen allowed 4-ft leeway for final positioning during sinking.

Approximately at El. −20, concrete was poured between the five rows of wells. Exact position was maintained throughout the sinking operation by triangulation from riverside stations set up at the start of the project. Once on the bottom, the caisson was progressively sunk to the designed elevation by mucking through the sixty 15-ft wells with clamshells and by adding concreting between the wells as the caisson sank. The watertight outer steel plate walls were built up during sinking operations until the over-all height of the caisson totaled 106 ft.

The river bottom at the west anchorage was mostly hard clay. Sharp-toothed heavy digging buckets were required for the dredging, and high-pressure rotary water-jets frequently had to be called into play to loosen the clay between the wells. These jets were made of a 12-in. vertical pipe leading to twin 4-in. horizontal distributor pipes fitted with 1½-in. nozzles which produced a water pressure of 350 psi. Horizontal struts fitted at intervals along the length of the vertical 12-in. pipe kept the jet centered in the well. Clay loosened by the jet action was removed by air lift. Constant soundings, using mushroom-shaped weights lowered through each well, furnished data for keeping the bottom uniformly level.

After the caisson was founded, a tremie seal was placed inside the cutting-edge chamber and inside the wells to a height of 15 ft above the cutting edge. The channel-side row of five wells was then capped with precast lids at El. −20 to create a step-back 18 ft wide. An overhang 20 ft wide and 15 ft deep was built on the shore side at El. −10. The overhang was built within a three-sided cofferdam coupled to the caisson.

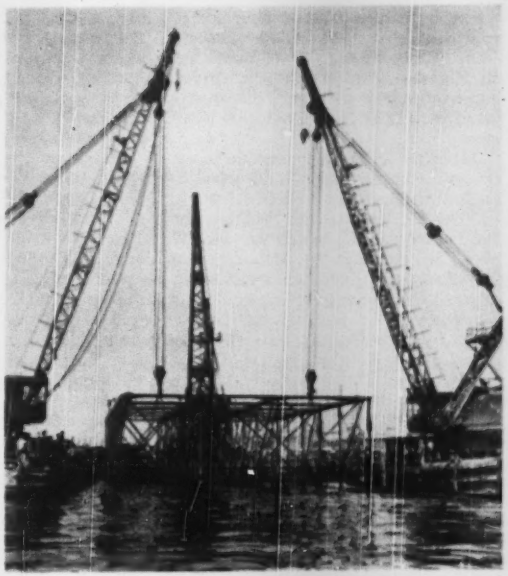
A 10-ft thick reinforced concrete distribution block was then placed over the entire pier at El. +5. From this base, the anchorage was carried up in successive lifts, usually of 16 ft, to a final elevation of approximately 158 ft.

The caissons for the tower piers were considerably smaller than that for the west anchorage, but otherwise were similar in design and construction. Cutting edges for each were 69x116 ft, with 28 dredging wells 15 ft in diameter set in four rows. The east tower caisson was founded at El. −115.5, and the west tower caisson at El. −87, and here again dredging had to be done through a hard clay bottom.

After the tremie seals were placed, the dredging wells of the tower piers were dewatered to a point where the two outer rows of seven wells of each pier could be capped with precast lids at El. −30, to create step-backs. The inner rows of each pier were carried up to El. +5, where they were capped by a 15-ft reinforced concrete distribution block 45 ft wide by 116 ft long. On each side eight buttressses were erected with their bases at El. −30 (the elevation at which the outer rows of wells had been cut off and capped) and extending up to El. −11.0.

The most dramatic problems in coordination of personnel, supplies and equipment arose during construction of the east anchorage pier, which because of shallower water was built by the cofferdam method. Most of these problems were linked with placement of the record-size tremie seal. The early phase of the pier's construction also was somewhat unique in that sheetpiling for the 99x225-ft cofferdam was driven after the bracing had been placed.

Because of the extensive area involved, the bracing was built in four separate and approximately equal sections, 57x99x49 ft deep. Of all-welded construction, they featured four sets of 14-in. horizontal wales, cross braced so as to provide clear dredging spaces of 18x18 ft at all points of the cofferdam. Each vertical panel was braced diagonally with light angles.

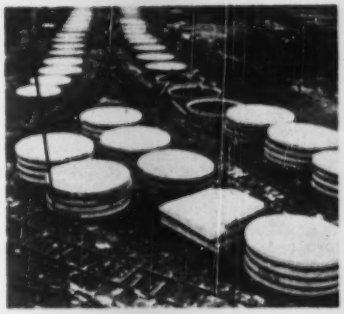


FLOATING CRANES lower bracing for east anchorage cofferdam into river from barge deck. Extreme size of cofferdam necessitated construction of bracing in four sections. Sections were bolted together under water by divers. Steel sheetpiling was driven around perimeter of bracing after it was positioned.

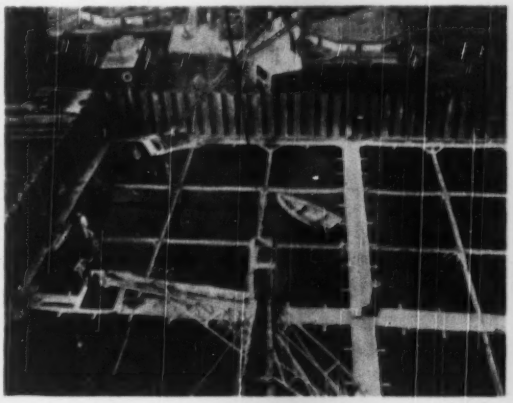
The first section was completely fabricated ashore and then skidded aboard a barge for delivery at the cofferdam site, which had been dredged to El. −42. It was then dropped by crane into a position marked by six spud piles, which also served as suspension supports. When in position, the top wale just cleared high-water level.

The three remaining sections were partly fabricated ashore and partly aboard barges so as to save shoreside space needed for the steadily increasing amount of construction material arriving at the terminal. Towed to the site, they were lowered into position next to their spud pile guides in the same way as the first section. Each section weighed approximately 140 tons and was dropped into position by revolving cranes, two of 50-ton and one of 75-ton capacity. Divers then bolted each section to its neighbor.

Sheetpiling was driven along the sides of the sections as they were placed. Altogether, 445 pieces of MZ-38 piling were used in 100-



PRECAST COVERS, fabricated on shore, were used to cap 15-ft-dia wells of west anchorage caisson to provide 18-ft step-back on channel side of anchorage block.



TREMIE SEAL of east anchorage cofferdam is poured from two floating batching plants working from opposite sides of cofferdam. Record continuous pouring operation, almost 27,000 cu yd of concrete, required 46,000 bbl of bulk cement and 45,000 tons of aggregate. Operation continued through 177½ hours.

ft lengths, driven to a top elevation of approximately +15. One floating crane fitted with a 165-ft boom set all the sheeting, which was driven home by four floating piledrivers fitted with heavy double-action hammers.

After the cofferdam was in place, revolving cranes using 2-cu yd shell buckets dredged the river bed down to El. −68.5. Unlike the bottom on the Delaware side, which was mostly clay, the bottom at the anchorage was mostly sand. Remnant overburden close to the bracing, which could not be removed by bucket, was broken down by high-pressure water jets and pumped to the surface by air lift.

After final inspection of the cofferdam by divers, plans were carefully synchronized for the record-size tremie placement, one of the most critical operations of the entire project. To place the seal, an uninterrupted pour of almost 27,000 cu yd of concrete was required. Just a few typical figures emphasize the logistic problems involved and the precision required ashore and afloat to feed the two floating mixing plants which carried the 177½-hour, nonstop operation through successfully. Approximately 46,000 bbl of cement were used at the rate of some 5,800 bbl per day. Of the 100 railroad cars of cement used, 16 were on hand when the pour started. The rest were delivered on a schedule which called for arrival of roughly 20 carloads per day at the pier terminal for transshipment by conveyor to 600-ton covered barges.

Sand and gravel similarly had to be timed for delivery as needed from a commercial plant 30 miles upriver. About 45,000 tons or 45 scowloads were required. To guard against emergencies, five loaded barges were kept moored near the site, ready for use in case delivery schedules were disrupted by accident or weather. A small bulldozer was slung aboard each aggregate barge while it was tied up at a mixer plant to help speed operations and insure maximum recovery of aggregate.

Working without interruption throughout the pour, the two mixing plants produced a combined average of 152 cu yd of concrete per hour. Plant No. 1, mounted on a 50x135-ft steel hull, carried a 50-ton revolving crane aft to load aggregate into batching bins which held 100 tons of sand and gravel and 250 bbl of cement. Aggregate bins discharged directly into 2-cu yd mixers, a set-up which eliminated the use of narrow discharging chutes which, during marine work, are likely to clog because of dampness. Concrete from the mixers in turn dropped directly into a tower hoist bucket, which was raised and automatically tripped at the level of the adjustable chutes leading to the tremie hopper.

Plant No. 2, mounted on a 40x170-ft steel hull, carried a 20-ton stiffleg derrick for handling aggregate, batching bins holding 80 tons of aggregate and 100 bbl of cement, and two 1-cu yd mixers feeding into a tower-hoist bucket.

While clamshells lifted sand and gravel to the aggregate bins from barges tied alongside the mixing plant, proportionate amounts of cement from the cement scows moored aft of the mixer plants were fed into the bins by Fuller-Kenyon pumps. Other pumps brought water and fuel aboard from shuttle barges. The mixing plants worked from opposite sides of the cofferdam throughout the operation, moving down its length as the tremie hoppers and 12-in. tremie pipes were periodically shifted to insure level placement. The 32-ft deep seal was poured in four passes of 8 ft each. Night operations were carried on under a bank of twenty 100-watt projector-type floodlights atop a 50-ft steel tower mounted on a floating power and light plant. It is a tribute to the men and equipment on the job that the entire operation was carried through on schedule with no interruptions because of plant or supply breakdowns.

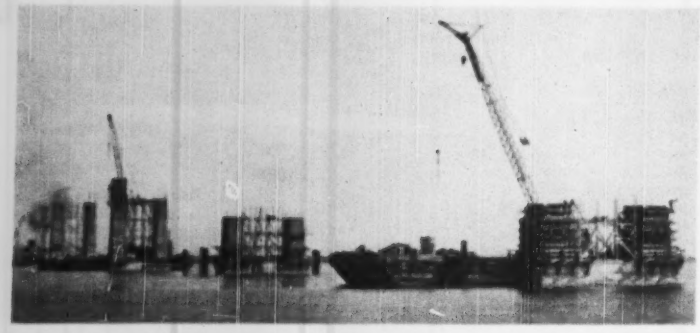
After the seal had been allowed to set for seven days, the cofferdam was dewatered, the top of the concrete being at El. −36.6. As planned, the lowest wales and shores of the bracing were firmly embedded in the seal. Before concreting was continued in the dry, the exposed part of the bracing was cut free to minimize internal stresses in the structure.

After surface laitance had been broken up with air hammers, swept up, and hosed off, 60 steel-plate well forms 15 ft in diameter were set on top of the tremie seal. All space between wells was interlaced vertically and horizontally with 1-in. reinforcing bars. Using movable steel forms for the exterior face, the block was carried up in 5-ft lifts. The well forms were carried up to El. +5, where a heavily reinforced 10-ft distribution block was poured. From El. −5 to +15, granite facing served in lieu of forms to retain the concrete.

Once the pier rose above the water level, the successive lifts which raised the anchorage to approximately 158 ft were carried out in a conventional manner. As this work progressed, divers were sent down to cut off the sheetpiling just above the top of the tremie seal. This sheetpiling, left embedded in the river, will permanently protect the seal against scouring.

Major share of the credit for overall coordination of the still continuing work on the Delaware Memorial Bridge belongs to W. W. Mack, formerly chief engineer for the Delaware Highway Department and now serving as director of the project. Consulting engineers are Howard, Needles, Tammen & Bergendoff, with Homer Seely, M. ASCE, as project manager, and O. H. Ammann, M. ASCE, and Moran, Proctor, Freeman & Mueser as consultants. A. Gordon Lorimer is consulting architect. For the contractor, Merritt-Chapman & Scott Corp., William Denny was project manager, working under the direction of Ralph E. DeSimone, vice-president in charge of marine and heavy construction.

(This article is based on the paper presented by Mr. Cotter before the October 13th Meeting of the Construction Division of ASCE during the Annual Meeting at Chicago.)



BARGE-BASED CRANES set forms for four west approach river piers to carry Delaware Memorial Bridge. Four-lane highway structure will have total length of 3½ miles including approaches, and will join Delaware's duPont Highway with New Jersey's Turnpike.

Land Leveling Procedure Utilizes Heavy Equipment

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Utah Agricultural College, Logan, Utah

Types of Land Leveling Classified

Type 1. Rough grading or cutting down of knolls and filling of hollows as performed by eye only.

Type 2. Cutting to exact uniform grade in two perpendicular directions.

Type 3. Cutting to exact uniform grade in one direction and to broken grade composed of two or more planes of different slope at right angles to the first grade.

Type 4. Cutting to exact level grade in one direction and to broken grade formed by two or more planes of different slope at right angles to the first grade.

Type 5. Cutting to exact level grade in one direction and to exact uniform grade at right angles to the first grade.

Type 6. Cutting to exact level grade in both directions.

LAND LEVELING for irrigation is the topographic conditioning of the ground surface to facilitate the uniform application of water and to utilize its consumptive use. It is a process of flattening or modifying the existing surface undulations rather than necessarily creating a completely level surface as the term might imply. Leveling of irrigated land has been practiced nearly as long as has irrigation, but only during the past ten or twelve years has mechanical equipment been available to obtain the high degree of accuracy now obtainable.

Only the engineering aspects of land leveling are here described but in many cases the economic and agronomic aspects of the problem will be the controlling factors. The estimated increase in crop return and estimated saving of irrigation water cost must at least equal the cost of the leveling project prorated into future years. The increase in crop return may come through more area in production or better growth conditions for the particular crop. The saving in irrigation water cost may come through use of less water, lower labor cost for irrigation, or a combination of both factors.

Determining Classifications

The classification of types of land leveling given in the box on this page is arranged in order of degrees of refinement of planed surface, progressing from the simplest toward the most refined. The classification chosen for a given grading job will be determined by the crop to be grown, the method of irrigation to be used, and the amount of money economically available for the work.

The first step is a rapid reconnaissance of the field, noting character of the soil, approximate length of the sides of the field, straightness of the edges of the field or property boundaries, occurrence of right angles at the intersection of the edges or property boundaries, and the location of the point of entry of irrigation water.

In some cases, the depth of soil should be measured with a soil auger to determine the maximum cut that can be made without removing the top soil. Clay or fine silt will shrink more under compaction than will organic material, and from the soil characteristics the shrinkage can be estimated. The length and straightness of the sides will determine the method of staking the field, and the point of entrance of irrigation water will indicate a control point in the calculation of grades. The field should be staked on a 100-ft square grid, with stakes driven to such a penetration that they will not be easily disturbed by men or equipment in the grading work. Builders' lath 48 in. long are best for stakes, and in most types of soil a penetration of 6 in. is sufficient.

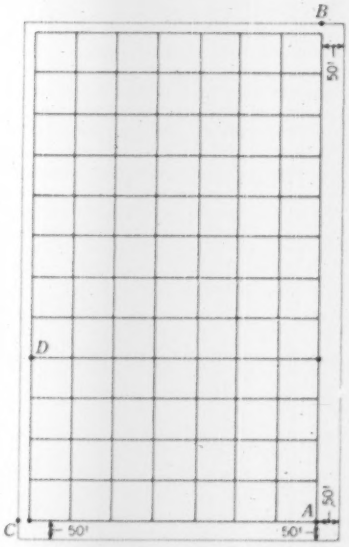


FIG. 1. GRID 100 ft square forms base for field topography and for cut-and-fill work. Grid is laid out on ground by stakes of builders' lath so marked that they can be read from tractor operator's seat.

Staking Without Transit

The process of staking a field for horizontal control is described for the simplest case where the sides are straight and the angles are right angles. In this case staking can be done without a transit. The first stake is driven 50 ft from a right-angle fence or property corner, as point A in Fig. 1; then two stakes are placed at the extreme edges of the field 50 ft from the fence lines as at B and C. The lines AB and AC are chained in with the stakes driven at each 100-ft station and aligned by eye with the far stakes B or C. On the line AC, and at the last full station before point C is reached, a right angle is turned with the tape, and a line parallel to AB is chained 400 ft to point D. A line is chained from the fourth station along AB from A, parallel with AC, until point D is reached and adjusted to its correct position according to the chained distance. With the alignment of CD, another 400 ft is chained and the process repeated until the entire field from A to B is covered by parallel lines perpendicular to AB.

A series of lines parallel to AB can now be chained, using the stakes in the perpendicular lines for alignment. The field will be covered by a grid which is 400 ft on a side. The intermediate stakes can be placed rapidly by taking line in two directions and checking with diagonal lines. When these stakes are in place, the field will be covered by the desired 100-ft square grid.

On a larger field where the foresights are not visible with enough ease to align with the eye, or where greater accuracy is required, as in a very flat field where the grade change per station is very small, the staking can be done with the aid of a transit. When a transit is used the procedure is much the same as has been described.

LAND AT PARKER, ARIZ., typifies Arizona areas not previously irrigated. Large-scale operations with heavy equipment are necessary for economical clearing and preparation of such land for irrigation.

In case there are no right angles in a field, the transit method must be used. The traverse should be completed in such a manner that the largest possible rectangular area is included within its boundaries. When the traverse is completed, the stakes outside the traverse are chained in by plunging the telescope and the remainder filled in by projecting the lines of the traverse and "filled in" stakes inside the traverse. In a field that has only one straight side, a line should be chained parallel to this side and 50 ft from it. At a station which will produce the longest line, a right angle can be turned and two right angled traverses run in. When the traverses are complete, the method proceeds as before.

Accumulated Error Limited

The method of filling in the stakes inside the 400-ft grids by eye may appear to allow excessive error, but the error of the grading operation will offset any small errors in alignment, and the accumulated error will not extend beyond the 400-ft block. If the original transit (or chained) rows are marked with waxed paper or cloth flags, greater accuracy and rapidity become possible. The stakes should be marked with their field coordinates, the rows being numbered and lines lettered (such as A-2, B-14) for convenience in later work.

When the entire block is staked, the breaks in natural grade should be noted and marked with plus stakes and these pluses recorded for office reference. Pluses include stakes at points on the fence lines where the distance to the nearest row of stakes is more than 50 ft. These stakes must be placed so that they will not give a false elevation at any local rise near a fence line. Any stakes closer than 50 ft from the fence lines should be omitted because they merely hinder the operator in turning his equipment when the dirt is moved.

Recording topography normally consists of three operations: plotting horizontal control, recording rod readings, and reducing the field notes. The grid system of control makes it advantageous to record notes on standard printed cross-section paper; a convenient scale is 1 in. = 100 ft. Each intersection of the cross-section paper will indicate a field station.

For reference, the lines should be numbered and the rows lettered in the borders to match the stakes in the field. The borders of the field should be sketched in and the plus stations on the boundaries plotted.

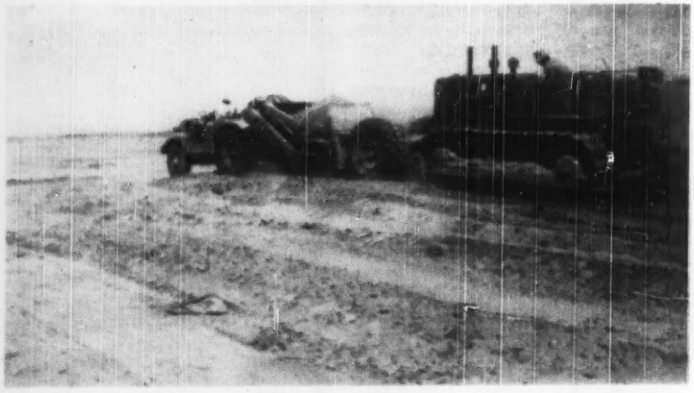
The approximate area can be calculated by counting squares and this value should appear on the map. The map should show the title or name of the property owner, location, date, and name of the engineer. It is also advantageous to record the estimated shrinkage factor of the soil.

Equipment to be used in the field should consist of an engineer's level, two stadia rods, a plane table, a fountain pen, two soft square lead "carpenter pencils," and the topographic sheet. The topographic party should consist of the following members: a levelman, two or three rodmen, and a recorder. The topographic sheet is taken into the field so that the rod readings can be recorded on it directly in ink with a suitable fountain pen. This procedure saves the entire time ordinarily used to plot readings in the office.

Rod readings are taken at each stake in the field. For future reference, as the rod is held against the stake a legible black line is drawn across the stake at the 1-ft mark on the rod. In a field where the surface has been loosened by cultivation, this practice is vital to the later step of marking cut and fill on the stake. Care should be taken that the level rod is tamped against the ground enough to break any clods and to give a true representation of the normal ground surface.

Recording Rod Readings

The rodmen walk along parallel rows across the entire instrument setup and then move down to a new set of rows and walk parallel to the

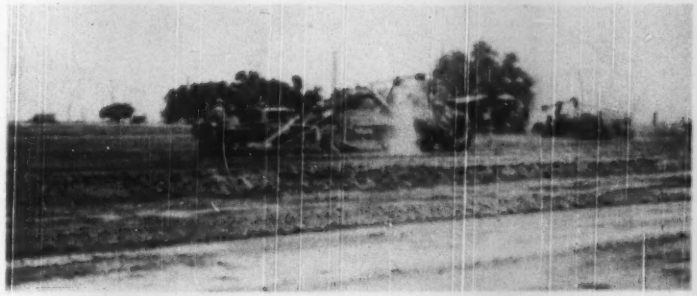


LAND NEAR PARKER, ARIZ., is leveled for irrigation by Allis-Chalmers Carryall scraper assisted by track-layer.

first course but in the opposite direction. The rods are read directly by the levelman and are recorded directly on the topographic sheet. As a precaution against error, one rod should always be read first, for example, the rod nearest the instrument. When each reading is obtained, the levelman waves to the rodman to proceed to the next station, and so forth until the setup is complete. When the rodman gives a reading at a plus station or a turning point, a suitable sign is made to inform the levelman that the station is not regular. When a rod is read on a turning point, the reading should be estimated to hundredths of a foot for greater accuracy. At all regular stations a reading to the nearest tenth of a foot is sufficient.

An instrument setup should be confined to a section of the field which is 1,200 ft square. The length of the longest shot will be nearly 850 ft but will be well within the limit of error of elevations carried to 0.1 ft. If the area of the field exceeds this maximum, more than one setup should be made. A turning point can be established on the corner of a setup which is common to the other setups.

A convenient arrangement of data is to record rod reading, elevation, calculated grade, and cut or fill of each stake in a quadrant around the station point on the topographic sheet. The rod readings can be reduced in the field at the time the topography is taken, or they can be reduced later in the office.



PLANING OF previously irrigated ranch land at Woodland, Calif., reduces use of water and improves crop return. Grades are designed to balance cuts and fills. Excavation of 300 cu yd per acre or more is estimated to cost 12 cents per cu yd.

LAND LEVELING saves cost of irrigation by lowering amount of water needed or by decreasing labor cost, or both. Here land near McFarland, Calif., is being leveled for irrigation by Caterpillar No. 80 scraper and tractor.

Calculating Grade, Cut and Fill

The basic problem in calculating grade for a land leveling project is to find a plane of such an elevation that the volume of cut above the plane will equal the volume of fill below, plus the shrinkage. Shrinkage is given as a percentage of the fill. It varies from 15 to 30 percent according to the soil type and, with experience, it can be estimated.

The primary step is to decide the best direction of irrigation. Then the type of land leveling to be used can be decided upon by a study of the natural ground slope as indicated by contours sketched in between station elevations. The contour interval chosen should be such that several contours appear, but not so many as to interfere with the addition of later data.

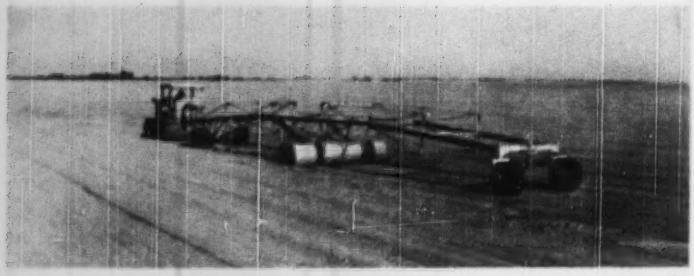
A method of calculating grades for type No. 2, exact uniform grade in two perpendicular directions, has been well described by Leon F. Stanley, Assoc. M. ASCE (CIVIL ENGINEERING for March 1948, page 46). For the remaining types a trial-and-error process can be adopted as will be described. If the average elevation of all stations in the field is calculated, a plane passing through this point at the center of the field can be tilted at any angle and the volume of cut above the plane will always equal the volume of fill below the plane. The necessary adjustment for shrinkage is made later.

The average elevation of each row of stakes can be found by adding the elevations of the stakes and dividing by the number of stakes. This average can be recorded above the row at the midpoint. The average row elevations can then be added and their sum divided by the number of rows to find the average elevation for the whole field. The other necessary information for the trial-and-error process is the control point through which the desired grade must pass, such as the elevation of the point of water delivery.

The grade is determined in the following manner: (1) Subtract the average elevation from the upper control-point elevation; (2) multiply the difference by twice the shrinkage factor; (3) add the difference from (1) and the product from (2) just found; (4) subtract the result of (3) from the average elevation of the area to find the lower control-point elevation; (5) calculate a uniform grade between the upper and lower control-point elevations. If the primary control point is on the lower side of the field, this procedure must be reversed.

A trial balance can be obtained by calculating grade, cut, and fill for every fourth line. If this balance is near the required balance, the other lines can be calculated. If the balance is too far from the desired result, a change in the trial grade should be made. When a balance is found for the entire field which is close to that desired, a block of stations on the lower end can be reduced or increased in grade, as if hinged at its junction with the remainder of the field, until the proper balance is reached.

The calculations for Type No. 5 can be accomplished by lowering the average elevation enough to allow for



USE OF HEAVY EQUIPMENT lowers cost of land leveling. Estimated crop increase and saving in irrigation cost must at least equal cost of leveling. Land leveler, pulled by Caterpillar Diesel D7, is seen preparing central California farm area for irrigation.

shrinkage, and using that elevation throughout the area.

The field party necessary for marking stakes consists of the following men—a party chief to read the marks from the map and from one to four men to mark the stakes. The equipment necessary for marking stakes is the topographic map showing cut and fill at each station, and for each man marking stakes, a folding rule graduated in tenths of a foot, and red and blue marking crayon. Each man marks the stakes in his row as the party passes down the field. When a series of rows is complete, the party moves to the next set of unmarked rows and returns along a path parallel to the first. The chief of party walks near the center of the line of men and calls the proper cut or fill to the men in rotation. Each man should call the marks back as a check. A frequent check of the map coordinates with the coordinates on the stakes should be made to avoid errors.

Stakes that are in cut are marked in red and the depth of cut is measured from the top of the stake down and filled in in red all around and to the top of the stake. The depth of cut is also written on the stake as an aid in checking grades.

Stakes that are in fill are marked in blue. A blue band is made around the stake at the height to which the soil must be filled. This is done by placing the 1-ft mark on the rule at the black-pencil mark, which was placed on the stake when the topography was taken, and by marking the blue band at the height on the rule which corresponds to the depth of fill. This procedure will prevent any errors due to the difference of penetration of the rule as compared with the penetration of the rod. The actual amount of fill is also written on the stake as an aid in checking grades. For greater visibility a blue line should be drawn down the stake with an arrowhead pointing to the blue band which indicates the height of fill.

Thus each stake will have both a numerical and a graphical representation of the cut or fill at the stake. The mark for no cut and no fill is a blue zero with a vertical line drawn through it. All marks should appear on both sides of the stake and should be legible enough to be visible from the equipment operator's position. To offset the larger shrinkage where fill is greater than 1 ft, the fill marks on the stakes should be increased by about 10 percent. For example, if a station has an indicated fill of 2 ft, the proper mark on the stake would be F 2.0, but the band around the stake would be 2.2 ft from the natural ground surface. In this case, the discrepancy is obvious, but in all cases the proper fill must be marked in numerals to aid in checking grades.

Calculating Earthwork

For earthwork calculations, only the volume of cut need be found. The square grids divide the field into equal areas and the prismoidal formula can be applied. An approximate value of the yardage in a grid can be calculated by multiplying the average number of tenths of feet of cut recorded in the grid by 37.

Even when a small amount of earthwork is to be computed, it is advantageous to construct a table with the sum of the cuts for one grid square in one column and their corresponding calculated yardages in the other. In this case the operation merely becomes a tabulation of yardage of cut for the sum of four small numbers, which can be easily arrived at by mental arithmetic.

To prevent confusion, the cut yardage for each grid square should be recorded in the center of that square. Then the total for each line can be placed in the right margin of the map and used as a sub-total. As a convenient check, the sub-totals can be found for each column as well as for each line, and when these numbers are totaled, the two results will check each other.

Earthwork Contracts and Equipment

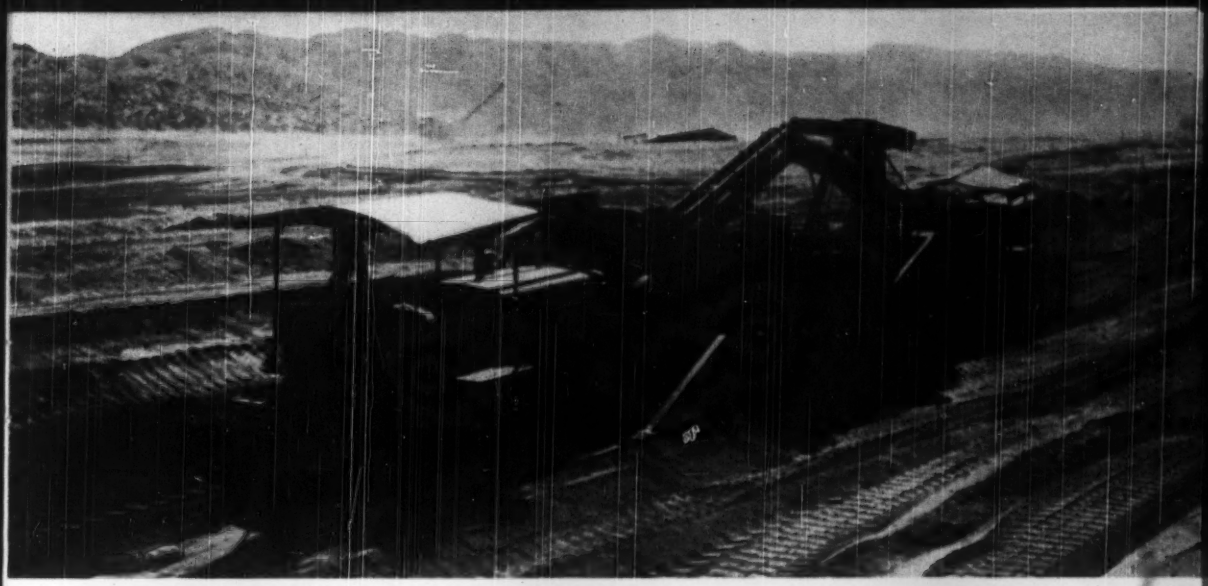
Contracts for earthwork on a land leveling project are awarded on a unit-price basis where the unit is the cubic yard of excavation. In some cases the equipment is hired on an hourly basis and the engineer is retained to act as an inspector to approve the quality and completeness of the work. In case the contract is to be awarded according to yardage, the engineer should prepare a "grade sheet" which should contain the following data: plan, showing cut or fill at each station; total yardage as calculated; net acreage of field; and cubic yards per acre for the entire field.

The basic earth-moving equipment to be used for such a project is an 8- to 18-cu yd scraper, such as is currently employed on highway work, with a tractor for motive power. There is a wide variation in types of scrapers and tractors, but for large projects the trend has been toward a combination of track-laying tractors and rubber-tired tractors pulling either cable-operated or hydraulic-operated scrapers with the loading of the rubber-tired tractor equipment aided by a "pusher" track-layer. Rubber-tired equipment is usually used for the longer hauls because of its greater speed, while the track-layers are usually used to control the finish grade because of their more precise control. In very light, sandy soil or in rough terrain, the track-layer must be used. Rubber-tired equipment may compact the soil unduly by passing too often over the same area.

Land leveling projects vary widely in cost because of variations in soil type, yardage to be moved, and average length of haul. For a given acreage, an increase in the yardage will decrease the unit cost because of the lower cost of finish grading per unit.

In fields where the excavation is below 300 cu yd per acre, the total cost will vary somewhat above 13 cents per cu yd, while if the yardage per acre goes above 300, the cost may drop to 12 cents, or slightly below. Bid prices on land leveling work have remained very much the same since 1946, since increased efficiency and keener competition have both been offset by an increased labor cost.

(This article is based on a paper presented before the Intermountain Section of ASCE by the author, when a senior student at Utah Agricultural College.)



SEVEN OR EIGHT MILLION cubic yards of embankment were built up in 26 miles of dike by 18- to 24-cu yd tractor-and-scraper rigs like that shown here. Dike was topped out by 12-cu yd bottom-dump trucks.

Dikes and Basins Protect Coachella Canal Against Flash Floods

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CONSTRUCTION of three big features authorized in the Boulder Canyon Project Act, approved December 21, 1928, were Hoover Dam, Imperial Dam, and the All-American Canal. Imperial Dam and the All-American Canal system were built during the period 1935–1947 at a cost of approximately $40,000,000. The over-all length of the All-American Canal is 204 miles, of which the Coachella Canal comprises a 123-mile branch. The alignment of the canal system is shown in Fig. 1. At its intake the All-American Canal has a capacity of 15,155 cfs; its branch, Coachella Canal, starts with a capacity of 2,500 cfs and extends northwesterly along the east slopes of Imperial Valley and the Salton Sea, enters Coachella Valley with a capacity of 1,300 cfs and crossing the valley floor and turning southward to end at mile 123.5 above Indio, serves 17,000 acres of presently developed land and 58,000 acres of new land to be brought under cultivation on completion of the project. An underground concrete pipe distribution system to serve the land is under construction.

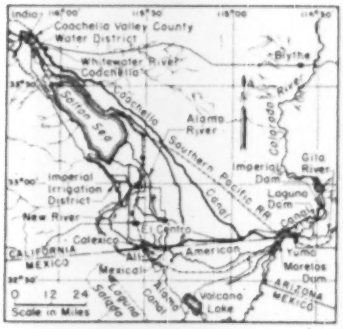


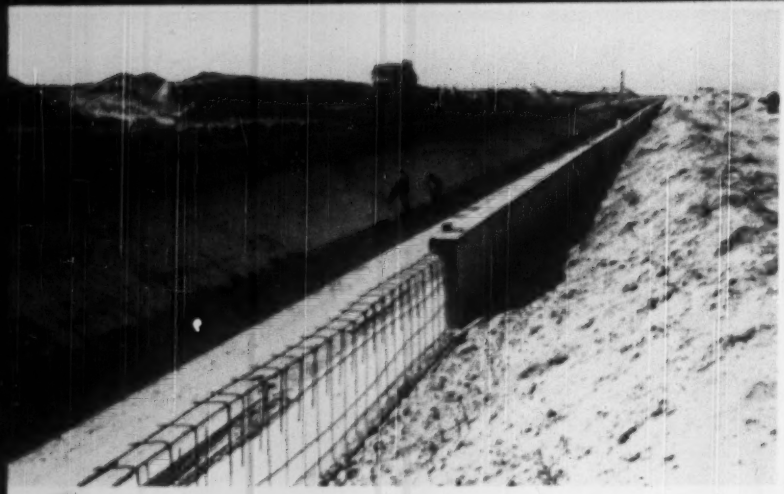
FIG. 1. COACHELLA CANAL carries Colorado River water 123 miles from All-American Canal to irrigate 75,000 acres of valuable date and citrus crops in Coachella Valley County Water District. Canal capacity is 1,300 cfs as it enters Valley.

In the 45-mile reach of the canal immediately upstream of its entrance to the valley, 32 wash siphons serve to pass flood waters from the adjacent mountain washes across the canal. The last 37 miles of the Coachella Canal is concrete lined.

High-intensity storms, centered over the steep mountain areas above the canal, occur during the summer and fall, and because of lack of vegetation result in large flash floods which carry heavy debris loads out of the steep mountain canyons to be deposited in great debris cones which form a portion of the irrigable land. Initial plans for the development of Coachella Valley contemplated the construction of overchutes and siphons for the passage of storm water across the canal. Although such a plan would protect the canal, it would provide no protection for the agricultural land and its irrigation lateral system lying on the lower side of the canal. For this reason protection dikes Nos. 1 and 2 to impound floods have been built for 26 miles along the upper, or easterly, side of the lined portion of the canal.

The design and construction of these flood control works are the subject of this article.

The maximum probable flood for washes crossing the Coachella Canal in the valley was determined by assuming the occurrence of a storm of maximum probable magnitude at a



WASTEWAY SECTION USED combines economy of trapezoidal form, permitting use of slipform for lining, with splash resistance of vertical walls and top coping.

time when ground conditions are conducive to maximum runoff. The protective works were designed on the basis of these floods. The size of the drainage areas, shown in Fig. 2, indicated that the maximum probable flood would be produced by a cloudburst type of storm. Since records of rainfall in Coachella Valley were inadequate to determine the size of such a storm, a study was made of the record of cloudburst storms in the Southwest. One at Avalon, Calif., on October 21, 1941, of 5.53 in. in 3½ hours, was considered large enough to be a probable maximum, and hydrographs of floods from the drainage areas shown in Fig. 2 for such a storm were derived and used to design the works.

With the benefit of extensive studies made in 1943 by the Los Angeles office of the Corps of Engineers, the Bureau plan provided for the concentration of two dikes forming storage basins and three concrete-lined wasteway channels for the evacuation of the impounded water, as shown in Fig. 2. The first basin is formed by Dike No. 1 extending for 16.4 miles along the 45-ft contour immediately uphill from the canal. Dike No. 2 extends for 10 miles along the 60-ft contour to form Basin No. 2, with its floor 27 ft higher than the canal water surface.

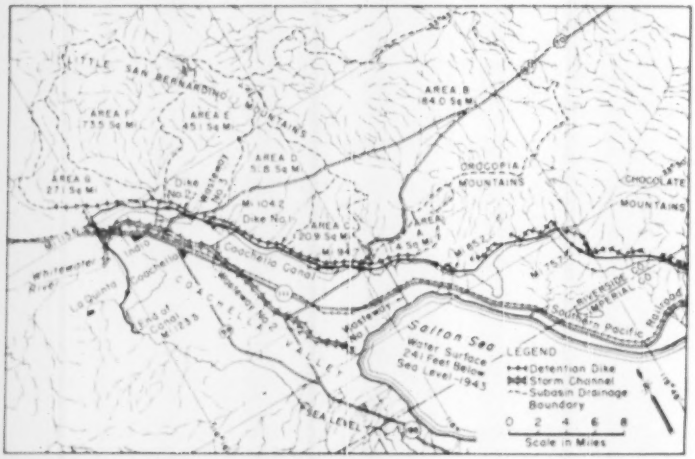
When a storm is centered over one of the drainage areas shown in Fig. 2, the rainfall and runoff from adjacent areas are reduced. The storage basin above Dike No. 1 was estimated to be subject to a runoff of 19,000 acre-ft from drainage areas A, B, C and D, and that for Dike No. 2 was estimated at 16,000 acre-ft from areas E, F and G. Ten percent was added to this pondage to take care of silting. Basin No. 1 is provided with two wasteway channels and Basin No. 2 with one. Wasteway No. 1, which is 15,300 ft long, discharges on the beach of Salton Sea. Wasteway No. 2, which is 6,150 ft long, and Wasteway No. 3, which is 9,150 ft long, discharge into the Whitewater River Storm Channel.

The areas between the dike alignment and the successive contour intervals upward from the contour on which the dikes rest were planimetered on a topographic map and the volumes added until the storage volume behind the dikes equaled the design pondage. For Dike No. 1, resting on contour 45, the required water surface for 21,000 acre-ft stood at El. 64. Allowance for settlement and for freeboard set the elevation of the top of Dike No. 1 at about El. 70, making this dike 25 ft high. Similarly the crest of Dike No. 2, resting on the 60-ft contour, was determined at El. 89.5 for detention of 18,000 acre-ft. The typical dike-section adopted has a crest width of 20 ft and slopes of 2:1 on the lower face and 3:1 on the upper face. The embankments were built with excavating and hauling equipment and placed in layers not over 8 in. thick. Borrow was taken from within the basins.

The storage basin behind Dike No. 1 is in reality formed of four subbasins connected by channels constructed between the dike and spurs from adjacent hills. To provide rapid dispersion of floods within a basin without undue velocity, these channels are constructed with a minimum base width of 200 ft. Where velocities in excess of 5 fps are anticipated, the 3:1 upper slope of the dikes is protected with a layer of asphalt 6 in. thick. A concrete cutoff wall 4 ft deep was constructed at each end of the asphalt mat, and a riprap blanket extends a minimum of 50 ft beyond each cutoff. The toe of the dike is also protected by extending the asphalt mat from 4 to 6 ft below the dispersion channel floor and covering this extension with riprap.

Wasteways Nos. 1, 2 and 3 consist of a culvert under the dike and canal, an automatic wasteway from the canal discharging into the culvert box, a concrete-lined wasteway channel, wasteway outlet structures and suitable outfall channels in earth. The wasteway channels are concrete

FIG. 2. **IN COACHELLA VALLEY**, Coachella Canal and irrigated lands below it get protection from flash cloudburst floods by 26 miles of dikes about 25 ft high, forming detention basins above canal.



UPHILL SIDE OF DIKE was riprapped to protect it against erosion of fast flowing water in detention basin formed by dike. Where rock from riprap was beyond economic haul, asphalt mat was substituted.

DISPERSION CHANNEL above Dike No. 1 leads flood waters to culvert (lower left) running under both dike and canal and into Wasteway No. 1.

lined and utilize a section designed to obtain the economy of a trapezoidal section, in which concrete lining can be placed by modern slip-form methods, plus the splash resistance of a rectangular flume section. The section adopted is shown in Fig. 3, which also shows the profile of Wasteway No. 2. Inside and at the top of the vertical walls, splash copings are provided. The water at maximum discharge varies in velocities between 25 and 35 fps as it passes down the slopes in the wasteways, and in all cases the maximum water depth is below the top of the trapezoidal part of the section.

Construction of the flood works by contract was initiated in February 1945 with the start of earthwork operations on the initial section of Dike No. 1 and its dispersion channels. This construction together with that for Wasteway No. 1, which was started in November 1945, provided protection to 9 miles of canal. The sequence of flood-work construction was such that where practicable the dikes and wasteways would be built concurrently with and immediately adjacent to the canal. Pending the resolution of questions relative to the repayment obligation of the Coachella Valley County Water District, construction was limited to the completion of a section of Dike No. 1 and to Wasteway No. 1, until January 1948, when construction was started on the final portion of Dike No. 1 simultaneously with that on Dike No. 2. Contract work on Wasteways Nos. 2 and 3 was started in May 1948. As the two dikes were completed somewhat in advance of Wasteways Nos. 2 and 3, the work on the wasteways was jeopardized by rain storms in the winter of 1948–1949. However, the wasteway contractor was able to complete all work on the channels and structures by January 1949 and was only slightly inconvenienced by minor rain storms.

The first section of Dike No. 1 was built by the Shea Co. of Los Angeles under an Order for Change to their contract to construct the earthwork, structures and reinforced-concrete-lined Coachella Canal, which parallels the dike through this reach. As the dike is separated from the canal by only a road berm along the uphill embankment of the canal, it was quite practical for the contractor to organize his work so as to carry on both phases simultaneously.

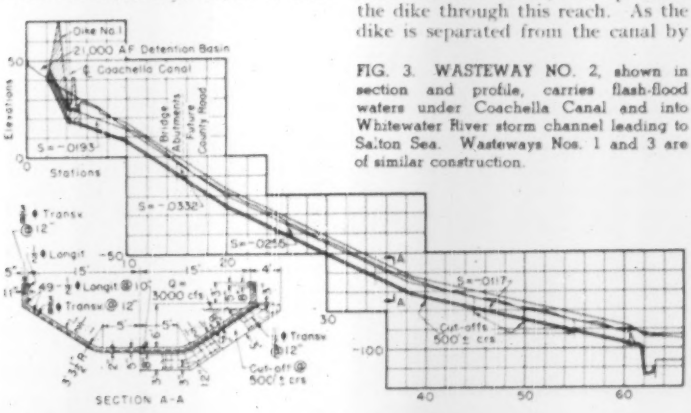


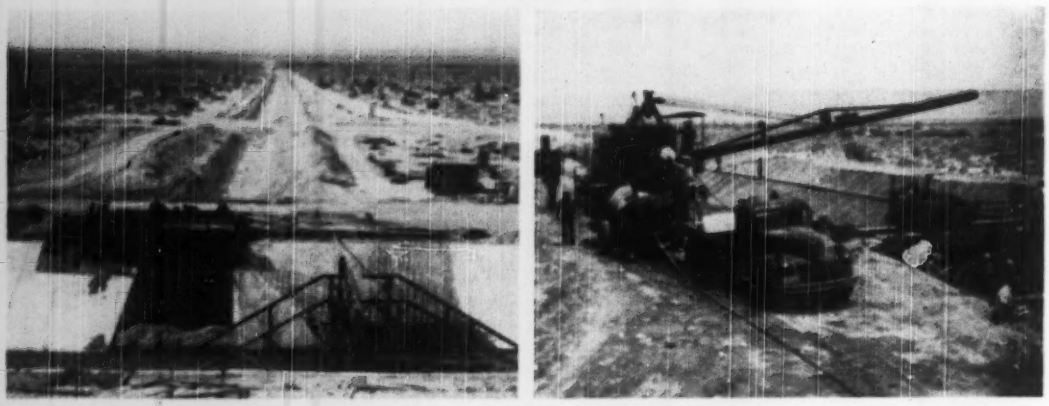
FIG. 3. WASTEWAY NO. 2, shown in section and profile, carries flash-flood waters under Coachella Canal and into Whitewater River storm channel leading to Salton Sea. Wasteways Nos. 1 and 3 are of similar construction.

Part of the material for canal embankments and all that for dike construction was obtained from borrow areas paralleling the uphill toe of the dike. When quantity estimates were originally determined, the canal alignment was adjusted so that all embankment material could be obtained within a distance of 800 ft of the toe of the dike. In his sequence of operations, the contractor first used tractors and scrapers to excavate material from the canal prism with which to construct a part of the canal embankments. He then shifted to the borrow area to secure the rest of the material needed.

The same tractor and scraper rigs that were constructing the canal embankment were then directed to a basing-in operation on the dike. As soon as the haul limit was reached for tractor and scraper operation, the contractor moved in with a shovel and 12-cu yd bottom-dump truck combination for the final operation of topping out the dike. Ramps at approximately 500-ft intervals were constructed for use by the wheeled equipment. These ramps were for the greater part constructed entirely outside the uphill neat-line slope of the dike and were left in place on the completed dike as the contractor considered their removal and use for dike material uneconomical.

Rock for riprap was hauled by truck from a quarry in Shavers Canyon near the Mecca-Blythe Highway and was spread on the slope by a bulldozer. The estimated average haul distance was 6 miles.

Operations connected with the construction of the dike proceeded quite



WASTEWAY NO. 1 (above left) consists of a culvert from Basin No. 1 passing under both dike and canal, an automatic wasteway from Coachella Canal (foreground) discharging into the culvert, and a concrete-lined wasteway leading to Salton Sea (in distance). Ice added to mix water (above, right) on Wasteway No. 1 keeps concrete temperature down to 90 deg in summer heat reaching 110 deg.

uniformly. At peak operation and when material was most accessible, the contractor was able to place an average maximum of 350,000 cu yd per month.

On August 18, 1945, a widespread heavy rain storm occurred in the valley, and runoff in the vicinity of the work reached flood proportions. A total of 2.20 in. of rain was recorded at Indio. The contractor suffered some damage to operating roads, embankment slopes and canal works, but aside from approximately 5,000 cu yd of material washed into the detention basin behind the dike by flood waters, no major effects of the storm were noted along the dike.

Equipment used by the contractor on the dike was generally as follows:

Embankment work:
- 1 2½-cu yd shovel
- 4 12-cu yd bottom-dump trucks
- 8 tractors with 12-cu yd drawn scrapers
- 1 80-hp tractor with dozer
- 3 130-hp tractors with dozers
- 1 3,000-gal water wagon

Riprap work:
- 1 2½-cu yd shovel
- 12 5-ton dump trucks

General:
- 1 grease truck
- 2 pickup trucks
- 1 light plant, 20 kw
- 1 motor grader (tandem with 12-ft blade)

Beginning in January 1948, the second and final section of Dike No. 1 was built by Marshall, Haas and Royce, contractors of San Mateo, Calif. Most of the material was moved with tractor and scraper units with pusher tractors assisting in the loading at the borrow pit. In heavy cuts, where such equipment could be advantageously used, the contractor employed a 2½-cu yd dragline and three 12-cu yd bottom-dump trucks. As on the Shea Co. section of Dike No. 1, this latter equipment was used primarily for topping out operations.

As the source of supply for rock was too remote to make riprap economical for slope protection, an asphalt mat was substituted. The contractor set up an 80-ton-per-hour hot-mix plant and, using screened native material from the alluvial fan on the nearby Thermal Wash, was able to lay down a very acceptable product. The mat material was hauled from the plant in trucks and transferred by bucket to a canal paver modified to lay down a flat strip of mat 10 ft in width. The lay-down on the slope was made in strips parallel to the dike center-line. By proper weighting of the paver, the mat density obtained, before any supplemental rolling, was at or above that obtained in the laboratory determinations of the maximum probable density for the material. A supplemental rolling up and down the slope, or at right angles to the lay-down direction, was effective in smoothing and binding the mat at the joints between lay-down passes, but this rolling was found to have little effect in increasing the over-all mat density. When the mat was inspected after it had been in place a year and a half, effects of weathering were not discernible.

The contractor was bothered somewhat by shutdowns due to wind storms. The fine sand in borrow areas was whipped up to such an extent that work was not only impossible but on many occasions dangerous. By wetting down borrow areas before excavating, the contractor practically eliminated dust problems and the attendant lost time due to shutdowns. Water was pumped from the canal adjacent to the dike and was distributed through the borrow area by means of a "Rainmaker" system of sprinklers. All work on this contract was completed in January 1949.

Major items of equipment used included:
- 1 2½-cu yd dragline
- 3 12-cu yd bottom-dump trucks
- 8 130-hp tractors with 18- to 24-cu yd scrapers
- 4 130-hp tractors with pushers
- 2 130-hp tractors with dozers
- 2 14- to 18-cu yd wheeled tractor-scrapers
- 1 motor grader (tandem with 12-ft blade)
- 1 water truck

For asphalt-mat construction:
- 1 80-ton hot plant
- 1 aggregate screening plant
- 1 ¾-cu yd dragline
- 1 paver
- 1 130-hp winch tractor
- 4 10-ton dump trucks
- 1 hand roller

Construction of Dike No. 2 was started in January 1948 by Claude Fisher Co., Ltd., and L. A. and R. S. Crow of Los Angeles. These contractors elected to throw the maximum of equipment into the work in an attempt to complete it all as quickly as economically possible. Fine material and borrow pits exposed to the wind caused delaying sandstorms. This contractor was forced to wet down the borrow areas to reduce lost time. At times his monthly rate of bank placement totaled 800,000 cu yd and his monthly average was 600,000 cu yd.

Equipment used on this work included the following:

- 6 130-hp tractors with 24-cu yd scrapers
- 5 crawler tractors with 24-cu yd scrapers
- 8 130-hp tractors with pusher plates
- 6 2-wheeled tractors with scrapers
- 2 130-hp tractors with dozers
- 2 water wagons
- 1 motor grader (tandem with 12-ft blade)

Fisher Construction Co. of Phoenix, Ariz., began work on Wasteway No. 1 in November 1945. This construction included 3.3 miles of channel, of which 2.9 miles were lined with concrete and 0.4 mile was in open cut. Also included was a concrete and structural steel railroad bridge, a reinforced concrete highway bridge and the channel-outlet and stilling-pool structure. All excavation of channel and structures was accomplished with little delay by tractors and scrapers and by dragline. The channel subgrade was trimmed to neat line by an endless-bucket type of subgrade trimmer, and the concrete lining was placed with a slip-form paver machine. Both these machines were designed by the Clyde Wood Co. and were manufactured and assembled by the contractor according to plans prepared by the Wood Co.

Concrete was batched at a centrally located plant. The paving mix was dry batched for mixing at the paver, while the structural concrete mix was batched into transit-mix trucks and placed at the structures by dragline or buggy.

Because of wartime depletions the supply of construction materials was critical, and considerable difficulty was experienced by the Government in securing adequate quantities for the work. An extension of time commensurate with the delay caused by failure of the Government to furnish materials on time made it necessary for the contractor to carry on the operation of paving the channel during an extremely warm period. In order that the temperature of the concrete at time of placement would not exceed the specification limit of 90 deg F, it was necessary for the contractor to start his work day in the early morning hours and also to cool the mixing water with ice. As the rate of placement was approximately 225 cu yd per day, and air temperatures on many days exceeded 100 deg, the quantity of ice used was considerable. In the placement of concrete in the channel lining, the mix was batched to the slip-form machine from a 34-cu ft paver equipped with boom and dump bucket. A trailer-mounted water tank was pulled behind the mixer, and ice was added to the water passing through this tank from the supply line to the mixer.

Even with air temperatures up to 110 deg and aggregate temperatures considerably in excess of 100 deg, it was possible at all times to maintain the temperature of the mix at the time of placement under a maximum of 88 deg by the use of this cooling method. The contractor was able to complete all channel lining and parapet wall construction on this contract by September 14, 1946. As the period starting about July 15 and extending through September is considered to be one when cloudburst storms are probable, it can be understood that considerable concern was felt by the contractor and by the Bureau during this time.

Major items of equipment involved in this construction included:

Excavation and material handling:
- 1 1/2-cu yd dragline
- 1 3/4-cu yd dragline
- 1 130-hp tractor with dozer
- 1 130-hp tractor with drawn scraper
- 1 sheepsfoot roller
- 1 motor grader (tandem with 12-ft blade)

Structural and channel-lining work:
- 1 pile-driver rig with boiler, hammer, etc.
- 1 water truck
- 1 60-hp tractor with side boom
- 1 canal subgrade trimmer
- 1 canal slip-form paver
- 1 34-cu ft paver with boom and bucket
- 6 two-compartment batch trucks
- 2 truck-mounted mixers, 5-yd capacity
- 2 trucks for gravel haul, 18-cu yd capacity
- 1 trailer-mounted water tank
- 1 aggregate batch plant
- 1 cement batch plant

Wasteways Nos. 2 and 3 were constructed by Macco Corporation of Clearwater, Calif., and work was started in May 1948. As this contractor rented the machines for trimming and lining the channels from the Fisher Contracting Co., the Wasteway No. 1 contractor, construction methods and equipment were very similar to those for that wasteway, and hence no list of equipment is given for construction of Wasteways Nos. 2 and 3. The method of supplying concrete to the slip form differed in that transit-mix material obtained from and delivered by Massey Rock and Sand Co. of Indio was used instead of dry batching to a paver at the slip form. By making alterations in the slip form such as the use of an endless conveyor from the mixer to a distribution hopper, the rate of placement was increased to a maximum of 300 cu yd per shift. This contractor's average for several weekly periods equaled the Fisher contract's daily maximum. Concrete material for structures was obtained from the same source as for the lining.

On completion of Wasteway No. 3, this contractor was directed to remove the shoo-fly dike built on Dike No. 2 for protection to this wasteway. Construction was completed without major incident in May 1949.

(The paper on which this article is based was presented before the Irrigation Division at the EIC-ASCE joint Toronto Meeting.)

REINFORCED CONCRETE LINING, placed by slipform, is required in wasteways since velocity in them may reach 25 fps.

Engineers' Notebook

Shrinkage of Concrete Blocks Calls for 30-Day Curing Period Prior to Use

PAUL C. NESS

Member of Student Chapter of South Dakota School of Mines and Technology, Rapid City, S. Dak.

A STUDY of the dry shrinkage of two types of concrete blocks was made at the South Dakota School of Mines and Technology by the writer, as part of his work in the civil engineering seminar, to determine the time required for curing before the blocks should go into the construction of a building. In this study the term "cinder blocks" was used for concrete blocks made with cinder aggregate, and the term "cement blocks" for concrete blocks made with sand and gravel aggregate. The test blocks used were supplied by the Dakota Lime & Brick Co.

The 13 cinder blocks used were taken from several batches, each batch composed of 20 gal of water, 7 bags of cement, 2,400 lb of cinders and 600 lb of gravel—equivalent to a water-cement ratio of about 1:2½.

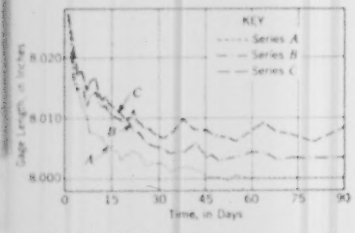


FIG. 1. CINDER BLOCKS cured under different humidity and temperature conditions shrank different amounts in same time period, but all reached approximately same percentage of total shrinkage in about 30 days. Blocks were divided into three series—*A*, *B*, and *C*—according to curing conditions. Series *A*, cured under relatively low, constant humidity at 70 deg F, followed comparatively smooth shrinkage curve for 90-day test period. Series *B* and *C*, exposed to outdoor temperatures of below freezing most of first month, with higher humidity than for series *A*, did not lose as much moisture initially, and hardening process did not progress as rapidly, permitting more variation in curves after first month. Blocks of series *B* and *C* will shrink more in course of time but never enough to intersect curve of series *A*.

All Blocks Cured in Kiln

All blocks were cured in a kiln for 14½ hours as follows: From 5 p.m. to 2 a.m., the temperature was gradually increased from 60 to 160 deg F by the injection of live steam causing a relative humidity of about 100 percent; from 2 a.m. to 7:30 a.m. the temperature was held at 160 deg, at which time the blocks were placed under two different curing conditions. The 13 blocks were divided into three series—*A*, *B*, and *C*—with four, five, and four blocks in each series respectively. On removal from the kiln, series *A* was placed in a room with a constant temperature of about 70 deg F with a relative humidity that was assumed to remain constant. Series *B* and *C* were placed on a concrete slab out of doors completely exposed to the elements. Eighteen days later, series *B* was placed under the same conditions as *A*, while *C* remained outside until the completion of the experiment, which covered a total curing period of 90 days.

Deformation Measured to 0.0002 In.

Immediately after the blocks were made, two nails, with punched and reamed holes in the heads, were placed in the sides of each block as near to 8 in. apart as possible. The Berry Strain Gage and Ames Dial were used to measure the deformation, the accuracy being about 0.0002 in. Because the change in length was the important factor, the exact initial length was not given special consideration. The shrinkage of the cinder blocks is shown in Fig. 1. It appears that shrinkage was caused by the drying out of the blocks. The rate of shrinkage varied inversely with the humidity of the air, and the length of the blocks varied directly with the temperature. Although several years may be required for a block to set completely, most of the set is accomplished in the first month.

The total shrinkage of the blocks in series *A* was 0.0275 in. in 8 in., a decrease in length of about 0.0034 in. per in. (Fig. 1). The allowable deformation after placement in a structure was taken as 0.0001 in. per in., or 0.0008 in. in the 8-in. gage length. This allowable unit deformation was determined from the usual formula:

$$\frac{S_t}{E} = \frac{240}{1{,}200{,}000} = 0.0001 \text{ in. per in.}$$

in which the values of tensile stress, S_t, and modulus of elasticity, E, were determined by experiment.

Assuming that all the shrinkage has taken place in 90 days, following the graph from 90 days toward zero days along the abscissa and increasing the ordinate by 0.0008, the graph of series *A* is found to intersect the increase at about 30 days. The same procedure for series *B* and *C* gives approximately the same results.

Cement Blocks Similarly Tested

Like the cinder blocks, the 13 cement blocks used in the investigation were taken from several batches. Each batch consisted of 15 gal water,

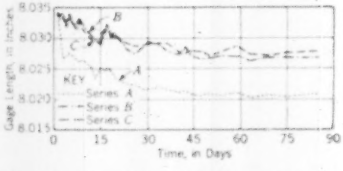


FIG. 2. CEMENT BLOCKS divided into three groups—*A*, *B* and *C*—and cured similarly to cinder blocks of Fig. 1, showed similar curing behavior but underwent only about half as much total shrinkage in 90-day curing period. Reason is probably that greater porosity of cinder blocks permits greater loss of moisture. Conclusion is that both cinder and cement blocks should be kept in yards for at least 30 days after casting so that shrinkage after placement in structures will be held to 0.0001 in. per in. or less.

7 bags cement, 2,800 lb sand, 2,200 lb gravel, and $3^1/_2$ lb of pozzolith—equivalent to a water-cement ratio of about $1:3^1/_2$.

The cement blocks were cured in a kiln for $14^1/_2$ hours in the same way as the cinder blocks, and like them were divided into three groups—*A*, *B*, and *C*—with five, four, and four blocks in each series respectively. On removal from the kiln, series *A* was placed in a room with a constant temperature of about 70 deg F and with a relative humidity that was assumed to remain constant. Series *B* and *C* were placed on a concrete slab completely exposed to the weather. Forty days later, series *B* was placed under the same conditions as series *A* while *C* remained outside until the completion of the experiment. The method of testing was the same as that used for the cinder blocks.

Cement Blocks Also Need 30-Day Curing

Like the cinder blocks, the groups of cement blocks cured under different humidity and temperature conditions did not shrink the same amount in the same length of time. The total shrinkage of the cement blocks in series *A* was 0.0138 in. in 8 in., a decrease in length of about 0.0017 in. per in., or only half as much as for the cinder blocks under the same curing conditions.

Taking the same allowable deformation after placement in a structure as for the cinder blocks, that is, 0.0008 in. in 8 in., and assuming that all the shrinkage has taken place in 90 days, it is seen from Fig. 2 that the graphs of series *A*, *B*, and *C* all intersect the increase at about 30 days. This means that no matter what the atmospheric conditions may be, dry curing of cement blocks, like cinder blocks, should continue for at least 30 days before use in a structure.

Shrinkage in Cinder and Cement Blocks Compared

The results indicate that cinder blocks shrink about twice as much as cement blocks, probably because they are more porous and lose moisture more easily.

The writer wishes to acknowledge the aid of Earl D. Dake, Assoc. M. ASCE, Professor of Civil Engineering, and other staff members of the South Dakota State School of Mines and Technology in the conduct of this investigation.

(The paper on which this article is based received second place in the student competition in the 1950 Rocky Mountain Conference of ASCE Student Chapters in Denver, Colo.)

Earth Pressure on Retaining Walls Determined by Diagram

KUANG-HAN CHU, Jun. M. ASCE
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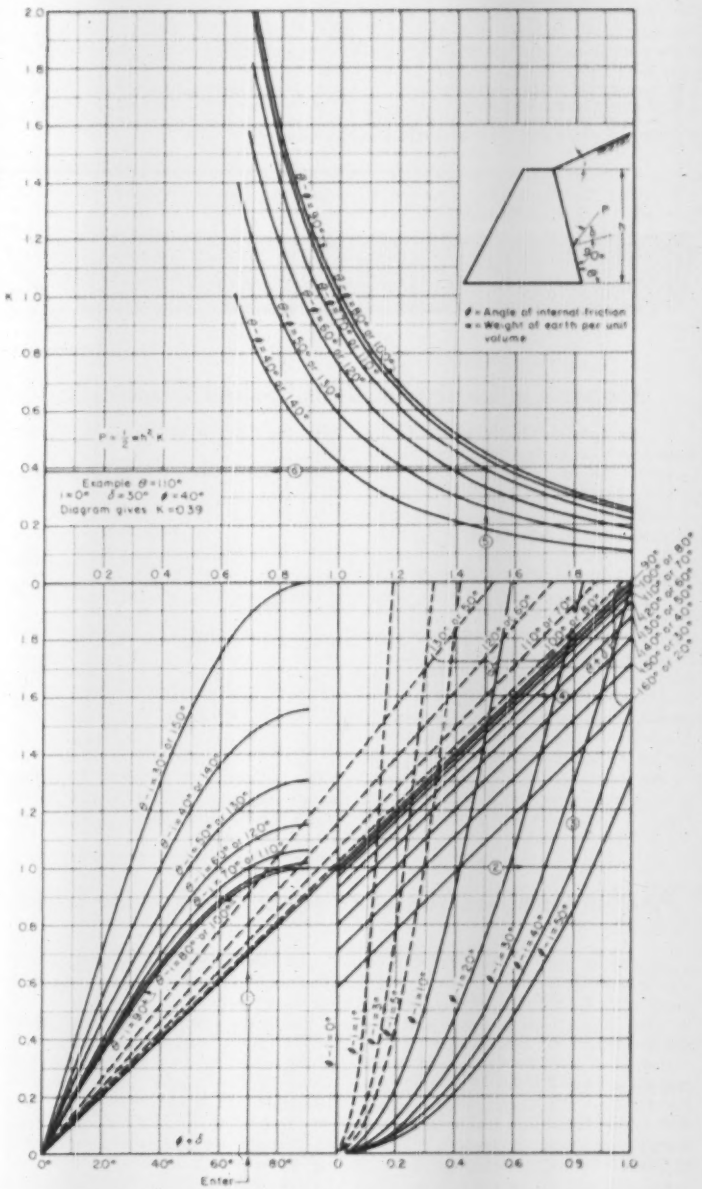

FIG. 1. DIAGRAM FOR COULOMB'S FORMULA solves example shown in six steps, indicated by circled numerals.

COULOMB'S well-known theory of earth pressure on retaining walls can be reduced to the following formula:

$$P = \frac{1}{2} w h^2 \times \left(\frac{\sin(\theta - \phi)/\sin\theta}{\sqrt{\sin(\theta + \delta)} + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - i)}{\sin(\theta - i)}}} \right)^2 = \frac{1}{2} w h^2 K$$

where

$$K = \left(\frac{\sin(\theta - \phi)/\sin\theta}{\sqrt{\sin(\theta + \delta)} + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - i)}{\sin(\theta - i)}}} \right)^2$$

w = weight of soil per unit volume
h = height of retaining wall
θ = angle of inclination of back of wall
δ = angle of wall friction
ϕ = angle of internal friction of soil
i = angle of inclination of backfill
P = resultant soil pressure

A nomograph for the solution of this formula was given by D. W. Taylor, Assoc. M. ASCE, in the *Engineering News-Record* of July 16, 1936. The diagram here presented, Fig. 1, was designed by the writer for the same purpose, to give increased convenience. In using the diagram to find the value K, follow the steps (1) to (6) as shown in the example given in the diagram.

This diagram was prepared by the writer at the University of Illinois under the supervision of Prof. W. C. Huntington, M. ASCE, head of the Civil Engineering Department.

...THE READERS Write

Moments in Continuous Beams Solved Graphically

TO THE EDITOR: In his article in the February 1950 issue, "Unsymmetrically Loaded Continuous Beam Designed by Graphical Calculus," Brent C. Jacob described an interesting method of computing moments and deflections.

The source of confusion in graphical methods is generally the evaluation of the scales of the funicular polygons. Mr. Jacob expressed the scales by the algebraic formula, which is convenient for a graphical solution and measurement by integraph. Computation of the scales based on the funicular polygon vectors can be found in A. Morley's *Strength of Materials* (1917), page 186. Computation of the scales can also be determined by the graphical method based on fixed-end moments, shown in the accompanying Fig. 1. The girder and loading in this figure are the same as those in Mr. Jacob's Fig. 1.

The fixed moments in Span 2 can be computed either by the tables or by the

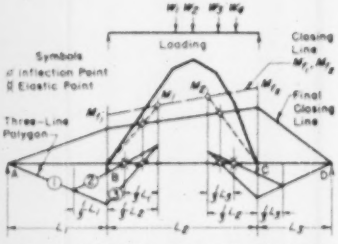

FIG. 1. BENDING MOMENT DIAGRAM shows graphical method of solving for moments in continuous beams.

diagrams. The closing line drawn through the fixed-end moments gives the central moments M_1 and M_2 at the third-point verticals. Lines M_1B and M_2C at the intersection with the inflection-point verticals give the closing points and the closing line of the final moments. The inflection points are determined by the three-line polygons.

The constants for the haunched beams are given in the writer's book, *Simplified Graphical Distribution of Moments* (1948). From the moment diagram in the accompanying Fig. 1, the deflection line can be drawn with the funicular polygon of the elastic weights. Therefore computation of the scales is reduced to one force polygon of the elastic weights only.

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Sacramento, Calif.

Another Simplified Tunnel Alignment Method Described

TO THE EDITOR: I have just read the excellent article on tunnel-driving alignment by F. K. Mateika, which appeared in your August issue. I have used a similar method with excellent results.

Instead of setting a single plug on the center line when it is desired to establish a backsight, set two plugs about 6 in. apart, both on the center line, and have the contractor's electrician fasten a light to one of them. Set an ordinary spad in the other plug and hang a short piece of flat sash chain from it. The long dimension of the head of the spad should be parallel to the axis of the tunnel, so that the long dimension of the chain will be perpendicular to the tunnel axis.

From a distance of 200 ft or so it is easy to line up the vertical hair on the center of the links. At long distances the chain shows up black, and makes a perfect backsight. It is not necessary to hang any plumb bob or other weight from the chain as its own weight will keep it hanging straight. Ordinarily the contractor runs his lighting circuit along one side of the tunnel for easy accessibility, so the only lights on the center line are those behind the chains. This makes it unnecessary to use monuments in the floor when marking the heading. It is faster to "wiggle in" on line than to set up over a monument. Since six or more chains can be seen in either direction from a single point, checking line becomes a routine matter. The contractor's activities are not disturbed in any way.

As to economy, a two-man party is sufficient on each shift, which is the irreducible minimum for a survey party. And 50 cents will buy enough chain for about two miles of tunnel.

ALLAN G. LOVE, Assoc. M. ASCE
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Large Savings Estimated from Constant-Angle Dam Design

TO THE EDITOR: The profession is in danger of forgetting the great contribution made to dam design by the American engineer Lars R. Jorgensen, M. ASCE, inventor and designer of the highly economical constant-angle arch dam, who died in 1938. It is estimated that Mr. Jorgensen was instrumental in saving approximately 36 million dollars of public money during the relatively short period of his professional activity as hydraulic engineer in Berkeley and San Francisco, Calif. An article in the October 1949 issue ("Arch Dam Conserves Wafer for Vail Ranches," by Earl Hagadorn) described the highly economical constant-angle arch dam in Riverside County, California. The great economy of Mr. Jorgensen's ingenious design has also been recognized abroad. (See Article in *Wasserwirtschaft*, August 1949, by Dr. F. Toelke, one of Germany's leading dam designers.)

The writer has estimated the actual savings realized by Mr. Jorgensen's design as incorporated in 61 dams built since 1912 (43 in the United States, 3 in Italy, 3 in France, 2 in Switzerland, 2 in Canada and one each in Alaska, Peru, Sweden, Japan, South Africa, Spain, Mexico and the Philippines). Table I gives the approximate yardage of concrete used in these dams, from which their cost can be estimated.

The economy of Jorgensen's type of constant-angle arch dam as compared with the gravity design now commonly used is well explained in B. F. Jacobsen's paper, "Stresses in Thick Arches of Dams" (PROCEEDINGS of ASCE, February 1926) in which the author states:

"The Pacoima Dam, a constant-angle arch dam approximately 400 ft high, is now under construction by the Los Angeles County Flood Control District. Its estimated cost is $1,750,000 and the saving, compared to a gravity dam, is in excess of $1,000,000. Besides, the constant-angle arch dam has a much larger factor of safety than the gravity dam."

Thus the cost ratio of the constant-angle arch dam to the gravity type is of the order of 2:3. For the Vail Ranch Dam, the cost per cubic yard was about $20, indicating that the cost of an equivalent gravity dam would be about $30 per cu yd. On this basis the savings realized on the dams listed in Table I would be 37 million dollars, since their total yardage is 3,707,000 cu yd. Some dams utilizing the design principles developed by Mr. Jorgensen may have been omitted from this table.

It is a matter of professional ethics to give Lars R. Jorgensen credit for his engineering achievements and for the large savings his design made possible for the taxpayers. Strangely enough, his contribution seems to have been practically forgotten.

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Consulting Engineer
Berkeley, Calif.

TABLE I. CONSTANT-ANGLE ARCH DAMS BUILT IN UNITED STATES AND ABROAD SINCE 1912

	Name of Dam and Location	Height, Ft	Concrete, Thousands of Cu Yd
A.	*Period from 1912 to 1920:*		
1.	Salmon Creek, near Juneau, Alaska	168	52
2.	Lake Spaulding, South Yuba River, Calif.	275	192
3.	Osmena, Philippine Islands	98	3
4.	Vauli River, Peru	62	1
5.	Sun River Diversion, Mont.	129	27
6.	Butte Creek Diversion, Calif.	45	1
7.	Clear Creek Tieton River, Wash.	90	4
8.	East Canyon Creek, Utah	190	16
9.	Kerckhoff, San Joaquin River, Calif.	108	25
10.	Gideaabacka, Sweden	85	5
11.	La Jogne, Switzerland	180	7
12.	San Clemente, Carmel River, Calif.	107	7
	Total for "A"		340
B.	*Period from 1921 to 1930:*		
13.	Amsteg, Reuss River, Switzerland	107	3
14.	Utayama, Japan	45	1
15.	Crocodile River, Hartebeestpoort, Transvaal	195	145
16.	Bullards Bar, Flathead Project, Mont.	183	47
17.	Upper Hubbart, Yuba River, Mont.	92	17
18.	Montejaque, Guadares River, Spain	273	35
19.	Lost Creek, Calif.	112	12
20.	Chiusella, Province of Turin, Italy	154	14
21.	Emigrant Creek, Ore.	115	14
22.	Mormon Flat, Salt River, Ariz.	229	43
23.	Gerber, Klamath Project, Ore.	82	12
24.	Concow, Lake Willenor, Calif.	100	7
25.	Cushman No. 1, Skokomish River, Wash.	280	90
26.	Big Santa Anita, near Los Angeles, Calif.	225	76
27.	Horse Mesa, Salt River, Ariz.	305	150
28.	Balch Diversion, Kings River, Calif.	100	10
29.	Santeetlah, Cheoah Creek, N.C.	202	217
30.	Buck Creek Diversion, Plumas Co., Calif.	96	20
31.	Grizzly Creek Diversion, Plumas Co., Calif.	90	18
32.	Glines Canyon, Elwha River, Wash.	200	20
33.	Reeder Gulch, Ashland, Ore.	112	15
34.	Cascades, near Rochester, N.Y.	140	66
35.	Pacoima, near Los Angeles, Calif.	375	215
36.	Van Giessen Diversion, Bear River, Calif.	100	22
37.	Deer Creek Diversion, Deer Creek, Calif.	112	9
38.	Yellow Creek, Tuscaloosa, Ala.	64	8
39.	Pigeon River, Waterville, N.C.	200	120
40.	Calles, Santiago River, Mexico	218	22
41.	Safford, Frye Creek, Ariz.	110	1
42.	Stewart Mountain, Salt River, Ariz.	212	117
43.	Calderwood, Little Tennessee River, Tenn.	230	280
44.	Juncal, Montecite Water Dist., Santa Barbara Co., Calif.	160	35
45.	Hogan, Calaveras River, Calif.	127	123
46.	Diablo, Skagit River, Wash.	363	316
47.	Lyons, South Fork Stanislaus River, Calif.	100	16
48.	Ceppo Morelli, Anze River, Province of Novarra, Italy	147	12
	Total for "B"		2,328
C.	*Period from 1931 to 1950:*		
49.	Ariel, Lewis River, Wash.	313	300
50.	Big Tujunga, near Los Angeles, Calif.	251	90
51.	Cat Creek, U.S. Navy Dept., Nev.	120	6
52.	South Fork, Nanaimo, Vancouver Is., B.C.	91	3
53.	Tiger Creek Afterbay, Mokolumne River, Calif.	120	30
54.	La Bromme, France	142	23
55.	Marèges, Dordogne River, France	295	242
56.	Comelico, Piave River, Province of Belluno, Italy	220	39
57.	Sautet, Drac River, France	414	131
58.	Barney Williams, near Phoenix, Ariz.	57	2
59.	Scanlon Dam, Lois River, British Colombia, Canada	195	120
60.	Mad River, for City of Eureka, Calif.	135	23
61.	Vail, Riverside Co., Calif.	150	30
	Total for "C"		1,039
	GRAND TOTAL of concrete yardage, cu yd		3,707,000

SOCIETY NEWS

New ASCE Officers Introduced and Members Honored at Chicago Meeting

THE CHICAGO MEETING of ASCE, to which the Illinois Section was host October 11–14, combined the Society's traditional Fall Meeting with a second Annual Meeting for 1950. Other innovations necessitated by adoption of the new Constitution included the introduction of new Society officers and the presentation of prizes and medals at the Wednesday morning opening session. The new officers—a President, two Vice Presidents, and six Directors—will assume office in January.

President-elect Gail A. Hathaway gave an analysis of engineering problems and his thoughts regarding the Society's proper approach to them in a brief address following his introduction to the assemblage. Commenting on the gratifying increase in Junior Members, he warned of the tendency to lose sight of the other grades, and of the need to stimulate new additions to higher grades of membership.

Engineers Joint Council activities came in for warm praise. In particular, Mr. Hathaway commented on the great service rendered through the committee that produced the report on the National Water Resources Policy. In this connection, he urged the continuing appointment of engineers to service on public bodies related to engineering matters in contrast to the usual set-up where every profession but engineering is recognized.

Better preparation for such public service is essential, he asserted. In his opinion, the Society may well encourage the ideal of engineers securing advanced college degrees and should, in fact, take an active interest in all training of civil engineers. Looking ahead, Mr. Hathaway urged intensive support for the celebration of the Centennial of Engineering in 1952.

The entire address was characterized by President Ernest E. Howard as a "call to renewed and progressive activity toward Society and professional betterment." Mr. Howard spoke briefly in response to a cordial welcome from Mayor Martin H. Kennelley. Other features of the opening session included the Executive Secretary's summary of the Annual Report of the Board of Direction.

Admiral Jelley Addresses Wednesday Luncheon

In one of the most challenging talks of the entire meeting program, Rear Admiral Joseph F. Jelley, M. ASCE, chief of the Navy Bureau of Yards and Docks, addressed the Wednesday general membership luncheon on the subject, "You Can't Buy National Defense." Deploring the fact that "it is the nature of most engineers to leave public business to others," Admiral Jelley emphasized the point that the civil engineering profession must be more deeply concerned with national defense.

He outlined the multiple defense projects that will require civil engineering "methods of analysis and training" and suggested that the Society "set up a military-liaison group consisting of the leaders of the profession and representatives of the military services . . . . to mobilize and direct the wealth of talent available on the Technical Division Committees." Admiral Jelley's address is published elsewhere in this issue.

Before the meeting adjourned the executive committee of the Board of Direction appointed the liaison group asked for.

VISITORS TO CHICAGO are welcomed by Mayor Martin H. Kennelley (lower photo). In upper view Elmer K. Timby, left, acting chairman of Construction Division, chats with Rear Admiral Carl H. Cotter, president of Merritt-Chapman & Scott Corp., during Division session at which Admiral Cotter spoke on "Foundations of the Delaware River Bridge."

ASCE PRESIDENT-ELECT GAIL A. HATHAWAY (left) is greeted by President Ernest E. Howard and introduced at Wednesday morning opening session.

Bomb Protection Discussed in Technical Division Sessions

The design of reinforced concrete structures to resist atomic bomb damage was discussed in a widely attended Structural Division session by Arsham Amirikian, M. ASCE, head designing engineer for the Bureau of Yards and Docks. Conceding that complete protection against the atomic bomb is impossible, Mr. Amirikian analyzed structural requirements for maximum protection against both impact penetration and blast resistance. His paper is excerpted elsewhere in this issue.

Major interest was also shown in the Soil Mechanics and Foundations Division session featuring a symposium on Chicago subsoils; in the Sanitary Engineering Division meeting on Chicago water and sanitation procedures; and in the Highway Division session describing the city's $445,000,000 comprehensive superhighway program. In all, twelve Divisions held sessions. Articles based on several of the papers appear in this issue.

Large Local Section Conference

Delegates from 26 ASCE Local Sections attended an unusually productive conference in the two days preceding the meeting. As detailed by Conference Chairman George S. Salter, the objective of the sessions was to strengthen and enlarge the service of the Society to its members at Local Section level. The program of prepared talks and open forum discussions covered operation of Sub-Sections, Wives' Clubs, and District Councils; the relationship of Sections to other engineering groups in the area and to ASCE Student Chapters; Section publications; integration of Junior Members into Section activities; and better utilization of Section funds. One of the most effective group presentations was made by three representatives of active Wives' Clubs—Mrs. L. S. Finch from Indianapolis, Mrs. G. I. Teufel from Seattle, and Mrs. A. D. Yanda from Cleveland, who told of the encouraging results of formation of Wives' Clubs in their Sections.

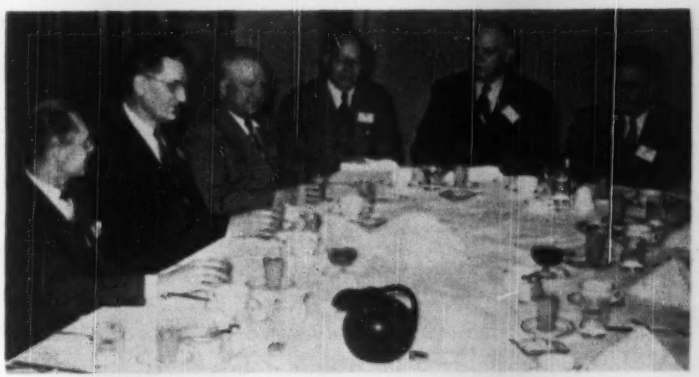
The resources of the Sections as related to civil defense programs were discussed, with reports from several Sections indicating that though extensive contributions are being made by individual Section members, as yet no coordinated Section programs have been developed. A detailed study is being made of this area of ASCE activity.

The increasing effectiveness of ASCE Student Chapters was indicated by reports and discussions at two conferences held in Chicago during the meeting week. Appointed Chapter personnel, including Faculty Advisers, Contact Members and the Committee on Student Chapters conducted a forum on detailed operation, while at another time the Student Chapter delegates (some 400 strong) met to consider new opportunities in the field of civil engineering practice.

Extensive arrangements to entertain the students were made by a Chicago committee headed by J. C. Chaderton, of the Navy Pier Branch of the University of Illinois. Finley B. Laverty, chairman of the ASCE Committee on Student Chapters, presided at a Faculty Advisers' Conference, which also met in Chicago.

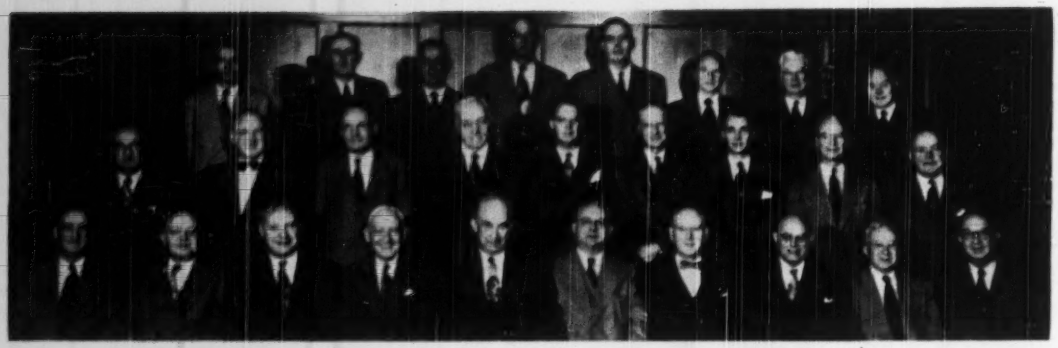
Extensive Social Program

Contributing greatly to the success of the meeting, which was attended by about 1,000, was a well-planned program of social events and inspection trips to several engineering projects of interest in the Chicago area. Nathan B. Bederman was general meeting chairman, A. L. R. Sanders, chairman of the Technical Program Committee, and Mrs. Louis R. Howson, head of the Ladies Activities Committee. Contributing to local interest in the Society and the profession was a Water Resources Policy Panel radio broadcast over a national hookup.



DAILY AUTHORS' BREAKFASTS constitute briefing sessions for all speakers, discussers, and program officials. Photographed (reading clockwise) are ASCE Director Waldo G. Bowman; Alfred H. Wieters, chairman, executive committee, Sanitary Division; Lawrence V. Sheridan, chairman, executive committee, City Planning Division; Craig P. Hazelet, chairman, executive committee, Structural Division; W. W. DeBerard, Hon. M. ASCE, city engineer of Chicago and author of article in this issue; and A. L. R. Sanders, president, Illinois Section and chairman of Technical Program Committee.

ASCE MEMBERS CONCERNED WITH OPERATION of Student Chapters attending Faculty Advisers Conference in Chicago are (front row, left to right, left-hand photo) L. H. Kessler; ASCE Director G. Brooks Earnest; Past-President Franklin Thomas; Finley B. Laverty, chairman, Committee on Student Chapters; P. H. McGauhey; F. W. Trezise; and Frank Edwards. In same order, second row, are W. G. Murphy, H. M. Reitz, Elihu Geer, B. L. Smith, H. S. Suer, Ernest L. Spencer, and E. I. Fiesenheiser. Top row, left to right, shows J. C. Chaderton, chairman of Chicago Student Activities, L. B. Ryon, E. W. Carlton, G. W. Bradshaw, A. A. K. Booth, N. D. Morgan, Jr., Director Walter J. Ryan, and H. W. Wood, Jr. In right-hand view, George S. Salter (seated, center) chairman of Local Sections Conference, meets with delegates from 26 Sections in Mid-Continent Area attending two-day Local Sections Conference during Chicago meeting week.



MEMBERS OF ASCE BOARD OF DIRECTION present at Chicago meeting include, left to right, front row, **Frank L. Weaver**, Director, District 5; **C. Glenn Cappel**, Director, District 15; **Albert Haertlein**, Vice-President, Zone I; **Henry J. Sherman**, Vice-President, Zone II; **Richard E. Dougherty**, Past-President; **Ernest E. Howard**, President; **Franklin Thomas**, Past-President; **Robert B. Brooks**, Vice-President, Zone III; **Fred C. Scobey**, Vice-President, Zone IV; and **Webster L. Benham**, Director, District 14. Pictured in second row, same order, are **Edmund Friedman**, Director, District 10; **Francis S. Friel**, Director, District 4; **Walter J. Ryan**, Director, District 12; **Charles E. Trout**, Treasurer; **G. Brooks Earnest**, Director, District 9; **Sidney T. Harding**, Director, District 13; **Waldo G. Bowman**, Director, District 1; **Harold L. Blakeslee**, Director, District 2; and **Kirby Smith**, Director, District 1. Back row, usual order, shows **Milton T. Wilson**, Director-elect, District 11; **Julian Hinds**, Director, District 11; **Morris Goodkind**, Director, District 1; **George W. Lamb**, Director, District 16; **Wm. N. Carey**, Executive Secretary; **Gordon H. Butler**, Director, District 7; **Louis R. Howson**, Director, District 8; and **Otto Holden**, Director, District 3.

Actions of Board of Direction at Chicago Briefed

SOME OF THE important actions taken by the Board of Direction in Chicago, October 9–10, 1950, are summarized here.

Budget

A balanced budget for the fiscal year 1951 was adopted based on an estimated income of $779,000, not including subscriptions to the Voluntary Fund.

Daniel W. Mead Prizes

Two Daniel W. Mead prizes were awarded—the Junior Prize to Roy G. Cappel, Jun. M. ASCE, New Orleans, and the Student Prize to G. L. Laverty, University of California.

Columbia Local Section

On petition of members resident in central Washington, and with consent of the Oregon and Spokane Local Sections, the Board approved formation of a new Columbia Local Section. This group has been operating for two years as the Columbia Branch of the Spokane Section.

Interim By-Laws Approved

Interim By-Laws were approved for guiding Society operations pending consideration at its February 1951 meeting of further comments from Local Sections received prior to January 1, 1951. The draft as cleared by the Board in February 1951 will be submitted to Local Sections for a second opportunity for comment. The Board anticipates adoption of a final draft at its October 1951 meeting.

Appointees to Division Executive Committees

(*a*) The Board appointed the following to membership on Technical Division Executive Committees, with terms expiring in October 1955: Air Transport Division, Ralph H. Burke; City Planning Division, Leslie Williams; Construction Division, C. D. Riddle; Engineering Economics Division, C. H. Mottier; Highway Division, Roy E. Jorgensen; Hydraulics Division, G. H. Hickox; Irrigation Division, A. P. Rollins; Power Division, C. C. Boswell; Sanitary Engineering Division, B. A. Poole; Soil Mechanics and Foundation Division, Arthur Casagrande; Structural Division, George E. Brandow; Surveying and Mapping Division, R. H. Lyddan; and Waterways Division, Carl B. Jansen.

(*b*) To fill unexpired terms of members of Executive Committees who have resigned or died, the Board appointed the following: Air Transport Division, Harry O. Wright, Jr., October 1952; City Planning Division, C. A. Blessing, October 1951; Power Division, I. C. Steele, October 1952; and Sanitary Engineering Division, H. B. Gotaas, October 1952, and Rolf Eliassen, October 1953.

Division on Engineering Mechanics

With the objective of fostering "activity and development in applied mechanics and other basic branches of knowledge, which form the background and foundation of the civil engineering profession" the Board authorized the organization of a Technical Division on Engineering Mechanics.

Reinstatement to ASCE Membership Is Simple Procedure

MANY MEMBERS OF the Society are dropped from the rolls every year. In the order of numbers, non-payment of dues, death, and resignation cause these separations. In spite of such annual losses, the total membership of the Society has doubled within the past fifteen years. This fact furnishes an effective measure of the general opinion held by civil engineers as to the value of membership in ASCE.

Many former members, particularly those dropped for non-payment of dues, are deterred from reestablishing their membership because of imagined difficulties connected with readmission. Comparatively few realize how simple the procedure for readmission is as established by the Board of Direction.

A former member, dropped for non-payment of dues and desiring readmission, is *not* required to pay the sum of the yearly dues for all the years he has been off the rolls. The full procedure for reinstatement follows.

For Members Off the Rolls for Less Than Three Years

Case 1. Dropped.

A former member dropped for non-payment of dues is required to request reinstatement in writing to the Executive Secretary. Unless some special circumstance demands referral to the Board of Direction, the former member will be re-

instated forthwith in his former grade of membership upon payment of (1) all or part of the current year's dues depending upon the month of reinstatement and (2) payment of dues for the earlier one-half year during which he received ASCE publications and services after being in arrears of dues, and payment for ordered items, if any, charged against his account when he was dropped from the rolls.

Case 2. Resigned.

A former member who resigned in good standing is required to request reinstatement in writing to the Executive Secretary. Unless some special circumstance demands referral to the Board of Direction, the former member will be reinstated forthwith in his former grade of membership upon payment of all or part of the current year's dues, depending upon the month of reinstatement.

For Members Off the Rolls for More Than Three Years

Case 3.

A former member dropped for nonpayment of dues or because of resignation in good standing and desiring reinstatement in his former grade is required to submit (on a special form furnished) a statement covering his professional record for at least the period he was off the rolls. He also must name three Members or Associate Members who have knowledge of these interim engagements. His application must be referred to the Board. He may then be reinstated upon payment of dues as detailed in Case 1 for members dropped for non-payment of dues or as in Case 2 covering members resigned.

In some cases former members desire reinstatement in a higher grade than that held when they resigned or were otherwise dropped. Reinstatement in a higher grade is permissible. Dues clearance, as outlined in Cases 1, 2, or 3 whichever applies, must be obtained and the difference in entrance fee and possible difference in dues as between the old and new grade also must be provided for. In addition, the regular application transfer form must be filled out showing professional record justification for election to the higher grade.

Except for former Juniors who have passed the age limit (32) for Junior Members, application for reinstatement in the former grade held, is the preferable procedure. Once reinstated, an application for transfer to a higher grade is handled in routine manner.

EJC National Water Resources Policy Is Reviewed by ASCE Committee

At its Chicago meeting the Board of Direction received the supplemental views of the ASCE Advisory Committee to the Engineers Joint Council Committee on National Water Resources Policy. The EJC statement and recommendations are to be found in "Civil Engineering" (July 1950, page 21, and August 1950, page 22). Here follow the supplemental views of the ASCE Advisory Committee.

1. Conservation and control of the waters of the United States are in the national interest, but the functions of the federal government should be limited:

First, to acting as trustee in the disbursement of tax revenues on a nonreimbursable basis to do those things and only those which are essential to the national defense or otherwise of substantial benefit to all of the people throughout the nation;

Second, to acting as a banker responsible for the soundness of his loans to aid in the financing of the cost of construction of works for the benefit of a limited number of people on terms equitable to all other citizens of the nation. These loans should be repaid with interest within a period of amortization less than the useful life of the works.

2. All control of water and all construction of water conservation projects should vest in the lowest governmental level practicable.

3. The federal government should not undertake any water development which is not economically justifiable. For determining such justification, there would be established criteria which are applicable to all functions of such development and to all federal agencies concerned. Reappraisals of such developments should be made from time to time, treating separately and realistically the benefits and the costs—by components where the development is multipurpose; in general the adjustment of both benefits and costs by the same multiplier is improper.

4. Regardless of the manner or the extent of participation of the federal government, no project or unit of a project should be deemed economically feasible unless the direct benefits which will actually be derived from its construction and operation will be greater than the total costs which will be incurred. All costs and benefits should be completely and realistically appraised.

5. The costs of every project for the development of the water resources of the United States should be paid for by those who benefit in the same proportion as they derive benefit. To the extent that such costs are paid by the federal government and thus become a burden upon the general public, the benefits which will actually accrue to the taxpayers should be in like proportion.

6. Authorization of federal water development should be solely by Congress.

7. Prior to authorization of any projects, the total probable cost and the sources of revenue to defray such cost should be defined clearly. After each such project is constructed, the actual cost should be reported with full explanation of all differences from the estimated cost.

8. The allocation of costs where a project or units of a project serve more than one purpose should be without favor to one function or to the prejudice of another, and the costs of joint facilities should be allocated to the several purposes on the basis of relative use without regard to the benefits presumed to accrue or to the sources of payment of such costs.

9. Authorized projects should make annual reports showing clearly and specifically the amount and nature of their costs with comparisons with the estimated costs on which their authorization was based. Such annual reports should be available by March 15 for the year previous, and should consistently follow standard accounting practice.

10. Irrespective of the purpose or function for which non-reimbursable expenditures are made or subsidies are granted by the federal government, each should be subjected to the test of what is best in the national interest. This test requires that the benefits to be derived from each such expenditure or subsidy shall be greater than the benefits which would accrue from the expenditure of a like sum for any other purpose or at any other location in the United States.

11. A uniform national policy should be prescribed for use in connection with all functions of federal water resources development and for use by all agencies with responsibilities in relation thereto. Until such basic policy has been adopted authorization for new projects should in general be withheld.

12. There should be created a board for the impartial analysis and appraisal of federal water projects and its review and report thereon should be prerequisite to the authorization or appropriation by Congress of or for projects of that kind.

For the ASCE Committee Advisory to Engineers Joint Council Committee on National Water Resources Policy

Henry J. Sherman, *Chairman*
Edmund Friedman
Sidney T. Harding
Julian Hinds
Louis R. Howson

October 9, 1950

Broad Scope of Centennial of Engineering Outlined

ELEVEN NATIONAL TECHNICAL societies and one from Canada have already taken formal action to participate in the international convocation which will celebrate one hundred years of engineering as an organized profession in the United States. This convocation, organized under Centennial of Engineering, 1952, Inc., is designed to "Provide an opportunity for all engineers to gather to exchange ideas and information of value to one another with no one group taking a place of special prominence."

At a meeting on October 12, the incorporators of Centennial of Engineering authorized President Lenox R. Lohr to extend invitations to an additional sixty technical societies in this country, and to appropriate societies of international scope, or of national scope in other countries. The international societies will be invited to hold their annual meetings in Chicago during the Centennial Convocation from September 3 to 13, 1952. Where it is not feasible for the societies of other countries to hold meetings in this country, it is hoped that they will send representatives to the convocation.

Early History of Civil Engineering

Before the year 1800, the only engineers were military engineers. For centuries they were the designers of fortifications, and were called keepers of the king's engines—catapults, battering rams, and scaling towers. Elements of the civilian economy, such as bridges, roads, viaducts, mines and buildings, were built largely by artisans with empirical designs developed from the experiences of their predecessors. The small industries of the day—cotton and flour mills, stonecutters and shoemakers—were largely family concerns utilizing limited help from their neighbors and not requiring the service of engineers.

Up to this time the United States had lacked even military engineers, and during the Revolutionary War had utilized Europeans. In the year 1802, West Point was founded, not primarily as a training school for officers, but to develop military engineers, and while its basic function has changed, it has remained under the supervision of the Corps of Engineers ever since.

With the march of progress it was realized that engineering had a scientific and economic basis, so the Corps of Engineers was called upon to build such projects as the Baltimore and Ohio Railroad. Even as late as the 1850's, the lack of American engineers made necessary the use of British engineers in designing the Northwestern Railroad. And to this day the engines run on the left-hand side of the track—according to the British practice.

With the introduction of steam power and the rapid economic expansion of the country, large manufacturing plants and major engineering works were developed and the need of civilian engineers was realized. Civil engineering was first taught in the United States in the 1820's. In the year 1852 the ASCE was founded. The designation civil engineer was quite different from that accepted today, being used to differentiate them from the specialized work of the military engineer. It included all branches of the engineering profession as well as architects. As the industrial revolution expanded to the giant concerns of today and as with the other professions, specialization became necessary. Various groups of engineers such as mining, mechanical, electrical, and chemical formed societies of their own, but all had their inception in the original society of civilian engineers founded in 1852.

America today enjoys the highest standard of living of any nation in the world. With 6 percent of the world's population it has 70 percent of the world's automobiles, 50 percent of the world's telephones, 48 percent of the radios, and it produces 32 percent of the world's manufactured goods. Without the engineer with his scientific background, mass production and mass distribution as we know them today would have been impossible. In general, he has been the unseen force behind management; operating under the aegis of our free-enterprise system that has made the United States the most powerful and prosperous nation in the world.

During the one hundred years that have passed since the founding of the American Society of Civil Engineers, the branches of the engineering profession have grown more specialized and less generally informed about the activity of the profession at large. The Centennial Convocation will give the engineers of the country an opportunity to attend meetings and hear technical papers of the other branches of engineering, and to obtain pertinent information on developments available to them from specialties outside their fields.

Centennial Celebration Plans

An important part of the Centennial of Engineering celebration will be an exposition during the months of July, August, and September 1952. The incorporators of the Centennial of Engineering have stated, "The purpose of the Centennial Exposition should be to tell the story of engineering and industry to the general public." The story of engineering and industry is one story. To take either without the other would be almost impossible. For this reason it is essential to the engineer that our industrial system be preserved on the same freely competitive basis on which it has been built.

This story will be told in many ways at the exposition which will be held at the Chicago Museum of Science and Industry. First in public appeal will be a stage production in the thousand-seat main auditorium of the museum. This show will be a dramatic human interest pageant about America—how it grew and prospered over the years, and how it can continue to grow. The essential role of the engineer and his industrial machine will be woven into the story just as it has been woven into our daily lives.

A permanent engineering exhibit will be built in the museum, where it may be open to visitors the year round for five years or more. This exhibit, occupying over eight thousand square feet of floor space, will utilize dioramas, models, and full-sized equipment to show the evolution of engineering and of the engineer over the last hundred years. This exhibit will contain examples of every field of engineering, and will be planned to show how the products of dozens of different specialties come together to make one complete complex machine.

An ideal setting for the Centennial Exposition is found in the Museum of Science and Industry, since it already contains scientific and industrial displays by many of the foremost companies in the United States. One of the many impressive exhibits is the full-scale coal mine. There are other exhibits in communication, transportation, and the sciences, which will be enlarged and expanded where needed for this great engineering fair.

Papers Placed in E.S. Library for Reference

NOT ALL THE worthwhile papers submitted for Society use can be printed as PROCEEDINGS Separates. With permission of the authors, a number have been filed in the Engineering Societies Library, fully indexed for more efficient reference. Brief résumés are here given. These papers supplement others previously noted in these pages, the most recent in July 1949. Estimates on photostating will be furnished by the Library, 29 West 39th St., New York 18, N.Y., on request.

Calculation of Shear in Wood Beams by the late C. J. Hogue, M. ASCE (about 3,500 words, text and mathematics, plus four diagrams). It is well known that shear in a wood beam checked in seasoning does not follow the customary formula for rectangular beams. New concepts are therefore pre-

sented, applying the principles to a cantilever, and illustrated by calculations on simple beams with multiple loads and with cantilever overhang.

Hydraulic Characteristics of Critical Depth Measuring Flumes by Karl J. Bermel, Assoc. M. ASCE (About 5,500 words, plus six photographs and ten diagrams). For improving the design of the San Dimas measuring flume, extensive clear water experiments were made in California showing behavior due to changes in operating conditions both up- and down-stream from the test flume. These resulted in valuable general data on flow characteristics for a relatively short open channel.

A Proposed Loading for Highway Bridges by T. Y. Lin, Assoc. M. ASCE (About 17,000 words, plus eight diagrams). Because of the inconsistency, inadequacy, and inconvenience of usual design loadings, a study of different effects on stresses was made, using influence lines and loading diagrams. As a result a highway bridge loading is recommended—800 lb per lin ft plus 32,000 lb concentration. For a fuller summary, see an article on page 43 of CIVIL ENGINEERING, April 1949.

Runoff from Hill Land—Flood Peaks and Hydrographs by L. L. Harrold, M. ASCE (About 4,000 words of text, plus three tables and nine diagrams). The object of the paper is to derive hydrographs of run-off from small drainage basins for various recurrence intervals. These make it possible to consider temporary flood-water storage in designing small hydraulic structures, with large potential savings in the aggregate.

Analysis for Three-Dimensional Pipe Structures by Group Relaxation by R. C. DeHart, Montana State College and Nicholas Bassar, Jr., Jun. M. ASCE (About 3,400 words, plus 18 tables and four diagrams). This group-relaxation procedure determines moments and forces at the fixed ends of a three-dimensional pipe structure subjected to expansion from temperature. It utilizes the principle of the neutral point method to evaluate elastic properties of the subdivided parts. Thus the factors required for distributing unbalanced moments and for eliminating restraints against translation are found.

Present Building Foundation Problems in Mexico City by Leonardo Zeevaert, Assoc. M. ASCE (About 3,000 words and seven diagrams). Discussing the strength of the volcanic clay under Mexico City, this paper shows how the deposit has improved through solidification. It is concluded that ground subsidence is not exclusively due to the many deep water wells that have been drilled. Aspects of local subsoil conditions and general behavior of building foundations are treated in same detail.

A. W. Van't Hul Awarded J. Waldo Smith Prize

AWARD OF THE J. Waldo Smith Hydraulic Fellowship is made to Arthur W. Van't Hul, who will do research work at the Colorado A & M College during the 1950–1951 school year, with the objective of determining an absolute roughness standard for open channel flow. His investigations will deal specifically with natural roughness conditions under control in the laboratory.

A. W. Van't Hul

Mr. Van't Hul became a Junior Member in the Society upon his graduation from the University of Illinois with the B.S. degree in 1949. He is now a hydraulic engineer with the U.S. Bureau of Reclamation at Denver, Colo.

Established by the ASCE Board of Direction in 1938, the J. Waldo Smith Fellowship was endowed by a bequest to the Society of the late J. Waldo Smith, Hon. M. ASCE. The fellowship, which currently carries a cash award of $1,000 plus an allowance of $400 for equipment, emphasizes practical research in the field of experimental hydraulics rather than purely theoretical hydraulics.

EJC Engineering Manpower Commission Begins Study

HOW BEST TO utilize engineering manpower in current and future mobilization for national defense is the subject of an intensive study currently underway by a nineteen-member Engineering Manpower Commission recently formed by Engineers Joint Council (CIVIL ENGINEERING for October, page 54). Established at the request of the National Security Resources Board, the EJC Commission seeks a practical method of reserving persons with specific engineering skills until they can be inducted either into military or government services on specific military requisition for those skills.

Meeting for the first time on October 12, the members of the EJC Commission named by the constituent societies and by ASEE, appraised the problem dropped into their laps by the National Security Resources Board.

David E. Christian, of the National Security Resources Board, amplified the need for recommendations from the EJC group. Reports of a similar meeting held under the auspices of the National Research Council were given by M. H. Trytten, director of the Office of Scientific Personnel, and Henry A. Barton, director of the American Institute of Physics, and a statement of actions taken by the Interdepartmental Committee on Scientific Research and Development was presented by Thomas Nolan, chairman of the Subcommittee on Scientific Personnel.

Task committees were then appointed to draft recommendations for consideration of the whole commission at a later date.

In addition to temporary chairman, E. G. Bailey, honorary member and past-president of ASME the following constitute the commission:

American Society of Civil Engineers: George W. Burpee, Coverdale & Colpitts, New York, N.Y., and D. W. Winkelman, president, D. W. Winkelman Co., Syracuse, N.Y.

American Institute of Mining and Metallurgical Engineers: Harry J. O'Carroll, Kennecott Copper Corp., New York, N.Y.; George B. Corless, Standard Oil Co. (N.J.), New York, N.Y.; and Max W. Lightner, Carnegie-Illinois Steel Co., Pittsburgh, Pa.

The American Society of Mechanical Engineers: George W. Codrington, General Motors Corp., Cleveland, Ohio; Ralph L. Goetzenberger, Minneapolis-Honeywell Co., Philadelphia, Pa.; and Carey H. Brown, Eastman Kodak Co., Rochester, N.Y.

American Institute of Electrical Engineers: O. W. Eshbach, Northwestern University, Evanston, Ill.; A. C. Monteith, Westinghouse Electric Corp., Pittsburgh, Pa.; and H. A. Winne, General Electric Co., Schenectady, N.Y.

American Institute of Chemical Engineers: W. I. Burt, B. F. Goodrich Chemical Co., Cleveland, Ohio; C. G. Kirkbride, Houdry Process Corp., Wilmington, Del.; and F. J. Curtis, Monsanto Chemical Co., St. Louis, Mo.

American Society for Engineering Education: Harry H. Armsby, Office of Education, Washington, D.C.; S. C. Hollister, Cornell University, Ithaca, N.Y.; and Thorndike Saville, New York University, New York, N.Y.

D. B. Prentice, member of the ASME, director of the Scientific Research Society of America, has been appointed executive secretary of the new commission.

FROM THE NATION'S *Capital*

JOSEPH H. EHLERS, M. ASCE
Field Representative, ASCE

ONE OF THE last actions of Congress before the recess was to provide initial funds for the National Science Foundation. An appropriation of $225,000 was made in P.L.843, Supplemental Appropriation Act of September 27, 1950.

Although the members of the Board have not yet been appointed, some prospective appointees have been approached concerning their willingness to serve.

Defense Contracts Have Priority

All defense contracts have been given priority status by the National Production Authority (Regulation 2, October 3, 1950). The priorities refer primarily to manufactured products and can be extended to suppliers of component parts and materials, but not to plant construction incidental to the supply order. Direct military and atomic energy construction projects may obtain priority aid but not indirectly through orders for manufactured products. Only defense and military contracts have received priority assistance from NPA. Those concerned with foreign assistance contracts, public buildings, and other government projects would also like to receive special treatment. The act authorizing the construction of veterans' hospitals contains reference to priority assistance for this work but they have not been included in any NPA regulations.

The first limitation order on construction has been issued. It prohibits the construction of specified types of projects whose purpose is recreation and amusement, such as bowling alleys, dance halls, and similar structures. Whether this is the forerunner of others and of sweeping wage and price controls depends on whether further large military appropriations are forthcoming after Congress returns. The NPA has a well-established construction materials division and will set up a construction projects division.

At a recent conference with NPA officials, construction industry representatives expressed opposition to limitation orders dealing with types of structures, but expressed approval for conservation orders requiring restricted uses of specific critical materials.

Residential Financing Restricted

Regulation X, effective October 12, which limits the amount that can be borrowed to finance residential construction, was announced by the Federal Reserve Board with the concurrence of the Administrator of the Housing and Home Finance Agency. The new regulation calls for down payments ranging from 10 to 50 percent and limits maturities in general to 20 years. Veterans receive preferential treatment. This regulation was designed to restrict the flow of funds into the mortgage market and through the reduction in new home construction to assure that materials and labor required for the defense program will be available. The regulations were designed to reduce housing construction to somewhat under 850,000 new units in 1951. Many businessmen connected with housing fear that the reductions may be far greater than officials predict and that a severe blow will be dealt to the home-building industry. There is some assurance that the regulations will be relaxed if too drastic results occur. Although the regulation was issued largely as an anti-inflation measure, it is being discussed and defended as a materials-saving device.

Scarcity of Metals Expected

With reference to the materials situation, steel, copper, and aluminum are expected to be critical materials. Despite a severe slash in residential construction, it is believed that more steel will be needed next year for construction than was used this year. The defense use of steel will require large tonnages of plates and sheets. Structural shapes should be plentiful if steel ingots are available. Currently the construction industry uses about 15 percent of the steel products made. There will be some saving in copper used in construction which currently uses 18 percent of the available supply. Of the 1950 supply of aluminum, 22 percent was used in construction. Even with increased supplies next year aluminum will be very scarce.

Substitutions for critical materials in engineering structures should be studied. Care must be taken that the substituting does not put the substitute material on the critical list too. Attention should be directed to eliminating unnecessary reinforcing steel and wire mesh and to designing with a view to using less steel, copper, and other scarce products.

Some current informed guesses on the overall construction situation for next year are about as follows: New residential construction will fall off from 30 to 50 percent below the current level, depending on whether the optimists or pessimists are correct as to the effects of the new Regulation X. Industrial construction, commercial construction, allowing for an increase in warehouse building, and public utility construction should remain at about this year's level. Highway construction should be higher than this year; reclamation and flood-control work will fall off perhaps 10 percent; military and naval construction may easily be two and a half times the $240 million current figure. Heavy cuts in government construction are recommended by the Bureau of the Budget. The civil works program of the Corps of Engineers, reclamation projects, public buildings, the programs for federal-aid hospitals, airports, and foreign relief all receive substantial cutbacks. The public works advance-planning program now in the Housing and Home Finance Agency will continue on a restricted basis, and will be directed towards defense needs.

District Section Starts Luncheon Meetings

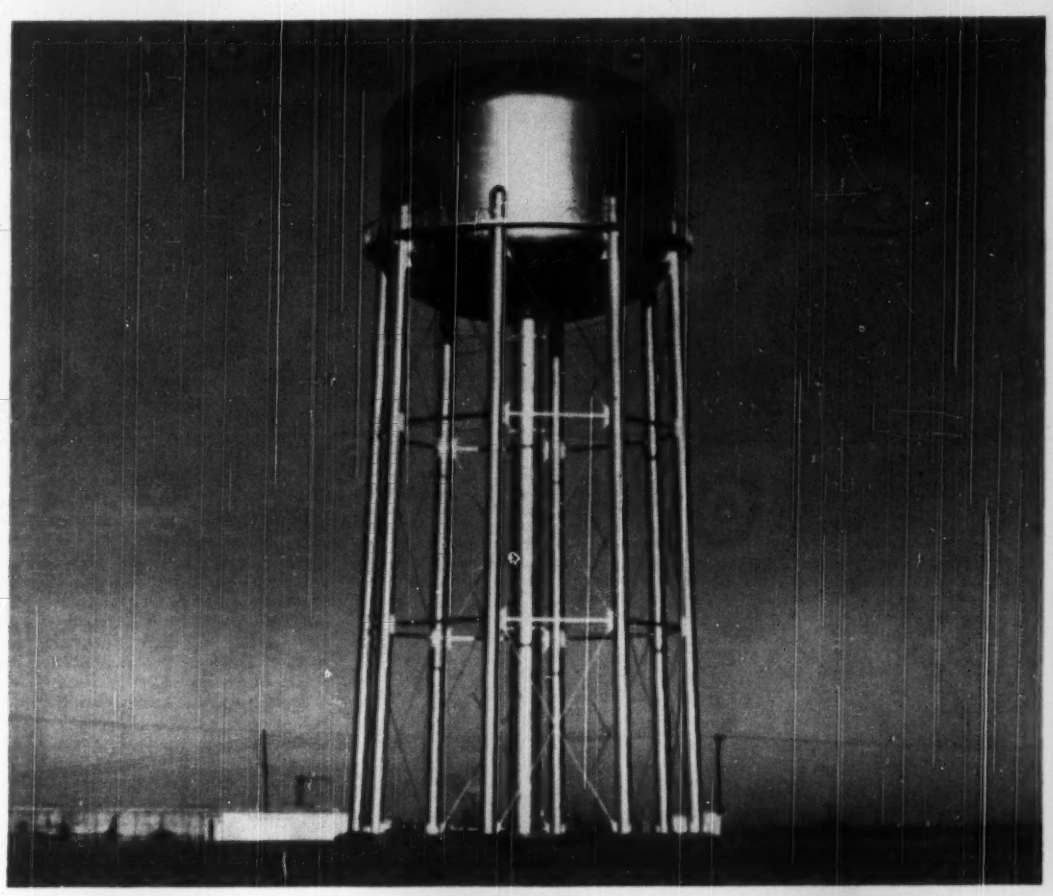
An interesting development in Society affairs in Washington is the inauguration of monthly luncheon meetings by the District of Columbia Section. These gatherings, supplementing the monthly technical sessions, are devoted to national affairs and economic problems.

District of Columbia Registration Board

A Board of Registration to handle registration of engineers in the District of Columbia under the bill recently passed by both Houses of Congress (S.3555) and signed by the President (October issue, page 53) will not be established for several months.

Public Health Service Active

A booklet entitled *Clean Water Is Everybody's Business*, just issued by the Public Health Service of the Federal Security Agency, reminds us of the growing importance of the PHS in the stream pollution field. Early this year the Federal Security Agency, under Reorganization Plan No. 16, was assigned the function formerly carried on by the Federal Works Agency in connection with making loans and grants for the design and construction of sewage treatment plants, and this work now largely centers in the PHS Division of Water Pollution Control. The enactment of uniform state laws relating to water pollution is being encouraged by the drafting of a Model Act to be submitted to the Council of State Governments at its meeting in Washington on October 19. Also indicative of this trend is the fact that Mark D. Hollis, M. ASCE, chief sanitary engineer officer of PHS, has been designated a representative on the Federal Inter-Agency River Basin Committee. This committee now consisting



How they solve water problems in the Texas Panhandle

The Texas Panhandle symbolizes the high plains and short grass country . . . where the economy is built on oil and natural gas, cattle and wheat. Here is Deaf Smith County where the water is supposed to cure bad teeth, and here also is one of the world's principal sources of carbon black and helium.

There is more to the story though. For this is also the land of the Dust Bowl and the great drought of 1935 that lasted seven years. Where rainfall had once ranged from 10 to 20 inches a year, during those trying times it averages less than 10 inches. Moreover, when it did rain, it came too heavily, in drenching down pours and washed away what little top soil had not already been blown away.

Though the drought has now passed, the problem of an adequate water supply still is of major importance in that area. However, many cities like Levelland have taken positive action.

Recently, this growing community of 8,330 installed a Horton elevated water tank to ease the whole situation. This 400,000 gallon structure now helps supply clear well water to services through 174,000 lin. ft. of distribution mains and 2,000 lin. ft. of transmission mains. And equally important is the fact that here is a dependable water supply . . . because it's backed by gravity pressure.

Tanks with the ellipsoidal-bottom design may be obtained in capacities ranging from 15,000 to 500,000 gallons. If larger capacities are required, tanks with radial-cone bottoms are built in sizes from 500,000 to 3,000,000 gallons.

For complete information about these streamlined, welded-steel tanks, write our nearest office.

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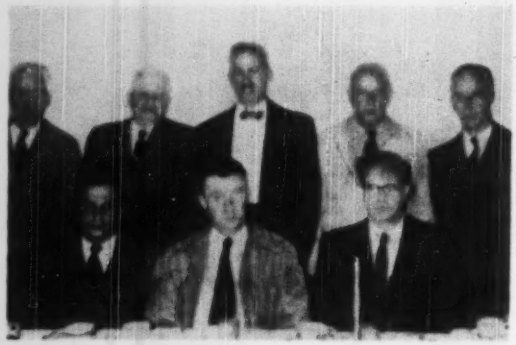
Birmingham 1	1596 N. Fiftieth St.	Havana	402 Abreu Bldg.	Salt Lake City 4	509 West 17th South St.
Boston 10	1009—201 Devonshire St.	Houston 2	2128 National Standard Bldg.	San Francisco 4	1584—200 Bush St.
Chicago 4	2199 McCormick Bldg.	Los Angeles 14	1556 General Petroleum Bldg.	Seattle 1	1309 Henry Bldg.
Cleveland 15	2263 Guildhall Bldg.	New York 6	3395—165 Broadway Bldg.	Tulsa 3	1647 Hunt Bldg.

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNA.

of representatives of the Corps of Engineers, Federal Power Commission, Agriculture, Interior, Commerce, and Federal Security Agency reviews river-basin development proposals involving multiple-purpose projects.

Washington, D.C.
October 26, 1950

GROUP OF OFFICERS AND SPEAKERS at recent meeting of Panama Section, with Panama Society of Engineers and Architects as guests, is shown. Reading left to right are Rex V. McKinley, secretary-treasurer of Section; Section Vice-President H. E. Clare, Jr.; Maj. D. H. Richards and Maj. J. Newton Cox, operations officer and officer-in-charge of Panama Projects, Inter-American Geodetic Survey; Col. Frank A. Petit, director of Inter-American Geodetic Survey; Francisco J. Morales, Jr., vice-president of Panama Society of Engineers and Architects; Jose B. Cardenas, president of Panama Society; and Col. Herbert D. Vogel, president of ASCE Panama Section. Colonel Petit, together with Major Richards and Major Cox, discussed Inter-American Geodetic Survey, which has for its ultimate aim production of accurate maps and charts of heretofore uncharted areas.



BUFFALO SECTION members sponsor recent luncheon meeting and inspection trip at Mt. Morris Dam, N.Y. Engineers directing project—M. V. Greeley, R. H. Gallinger, and B. R. Fuller—were speakers. Shown in front row, left to right, are L. S. Bernstein, Mr. Greeley, and H. I. Howell. In second row are R. E. Martin, Mr. Fuller, Mr. Gallinger, J. E. Harns, and R. T. Moore.

BRAZOS COUNTY BRANCH OF TEXAS SECTION and J. T. L. McNew Student Chapter at Texas A. and M. College are joint hosts at dinner honoring ASCE President Ernest E. Howard, Texas Section President L. D. Snow, and other guests. Shown here (left to right, front row) are Billy Stephenson, senior civil engineering student at Texas A. and M., Mrs. L. D. Snow, Mrs. Ernest Howard, Mrs. George Lacy, Mrs. J. B. Baty, Mrs. James Tidwell, and J. B. Baty, president of Brazos County Branch. In same order, second row, are F. M. Davis, vice-president of Texas Section; Chancellor Gibb Gilchrist of A. and M. College System; President Howard; Prof. R. L. Peurifoy, who acted as toastmaster; M. T. Harrington, president of A. and M. College; Mr. Snow; George Lacy, vice-president of Texas Section; and James Tidwell, Student Chapter president. Program included talks by President Howard, Mr. Snow, and others.

"Proceedings" Separates Available in Subscription

AVAILABILITY OF ANNUAL subscriptions to the entire list of PROCEEDINGS Separates is noted by the ASCE Committee on Publications. Requests for subscriptions, which cost $3 a year, should be addressed to Society Headquarters, 33 West 39th Street, New York 18, N.Y.

District 9 Council Holds First Meeting

THE FIRST MEETING of Local Sections in District 9 since formation of the District 9 Council, continues the joint two-day meetings of Local Sections in the area held at Chfty Falls State Park each fall since 1947. The principal speaker at the Saturday night dinner meeting (September 30) was Prof. Forrest H. Green, of Purdue University, who presented an illustrated travelogue on Egypt. Professor Green spent the past summer as highway consultant for the Egyptian government.

Speakers at the Sunday morning business meeting of the Council included Council Chairman Louis S. Finch, ASCE Director G. Brooks Earnest, and C. W. Lovell, Sr., who discussed plans for the 1951 Summer Convention of ASCE in Louisville, Ky. About 95 members and their families attended the weekend meeting.

Formed last summer, the District 9 Council has for its objective bringing ASCE closer to the membership and making the Society a greater force in District 9.

Coming Local Section Events

Arizona—Fall meeting in Phoenix, November 17-18.

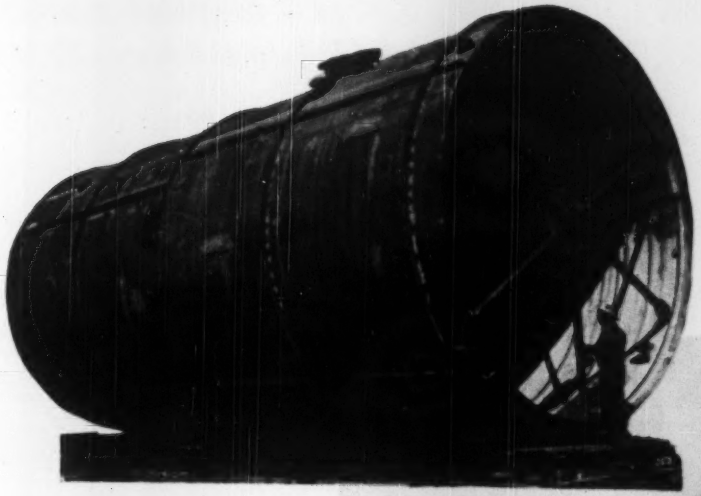
Cincinnati—Meeting in Cincinnati the first Wednesday of each month.

Cleveland—Dinner meeting at the Cleveland Engineering Society, November 17, at 6:30 p.m.

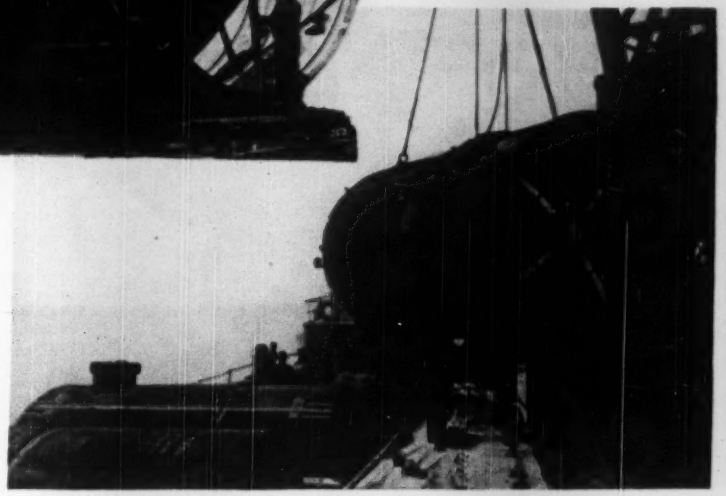
Colorado—Dinner meeting at the Democratic Club, Denver, the first Monday of each month.

Florida—Meeting at the Seminole Hotel, Jacksonville, November 14, at 7 p.m. Meeting of Gainesville Sub-Section on November 30.

Georgia—Annual meeting in Atlanta on December 9.



DIRECT WATER OR RAIL SHIPMENTS



BUILDERS OF HEAVY EQUIPMENT

Sections of a synthetic-crude column are shown being loaded at one of the deep water piers of the company for shipment to Perth Amboy, New Jersey. This 90-foot high column was a part of recent production at Newport News that has included both a hot and a cold catalyst hopper, fractionator tower, reactor, and other items for the chemical and petroleum industries.

The wide range of large facilities in the 225-acre Newport News plant are particularly suited for the production of heavy equipment. Constant investigation keeps the plant abreast of the developments in manual and automatic welding methods. Modern radiographing instruments and large stress-relieving ovens are included in the plant facilities. Your inquiries are invited.

NEWPORT NEWS

SHIPBUILDING AND DRY DOCK CO.

NEWPORT NEWS, VIRGINIA

Illinois—Weekly luncheons every Friday at the Chicago Engineers Club, at 12 noon.

Intermountain—Meeting in Salt Lake City on November 17.

Iowa—Annual meeting in Des Moines on November 16.

Kansas—Meeting in Topeka, November 17, at 6:30 p.m.

Kansas City—Annual business meeting in Kansas City on December 5.

Kentucky—Meeting in Frankfort, November 17, at 7 p.m.

Los Angeles—Seminar on construction practices at the California Institute of Technology, November 22, at 7:30 p.m.

Metropolitan—Meeting in the Engineering Societies Building, New York City, November 15, at 8 p.m.

Miami—Meeting in Miami the first Thursday of each month.

Michigan—Meeting at Ann Arbor on December 7.

Northeastern—Meeting in Boston on November 20.

Northwestern—Annual meeting in Indianapolis on December 4.

Philadelphia—Meeting in Philadelphia on November 14. Joint meeting of Delaware Sub-Section with local groups of the Founder Societies and the AIChE, at the du Pont Country Club, November 21.

Seattle—Dinner meeting at the Engineers Club, Seattle, November 22, at 6:15 p.m.

Spokane—Meeting of Columbia Branch in Richland, Wash., November 9.

Tacoma—Meeting in Olympia on November 13.

Texas—Luncheon meetings of Dallas Branch the first Monday of each month, at the Hotel Adolphus, at 12:15 p.m. Luncheon meetings of Fort Worth Branch the second Monday of each month, at the Blackstone Hotel.

West Virginia—Dinner meeting at the Hotel Frederick, Huntington, December 1, at 7 p.m.

Scheduled ASCE Meetings

WINTER CONVENTION
Houston, Tex., February 21–23
(Board of Direction meets February 19–20)

SUMMER CONVENTION
Louisville, Ky., June 13–15
(Board of Direction meets June 11–12)

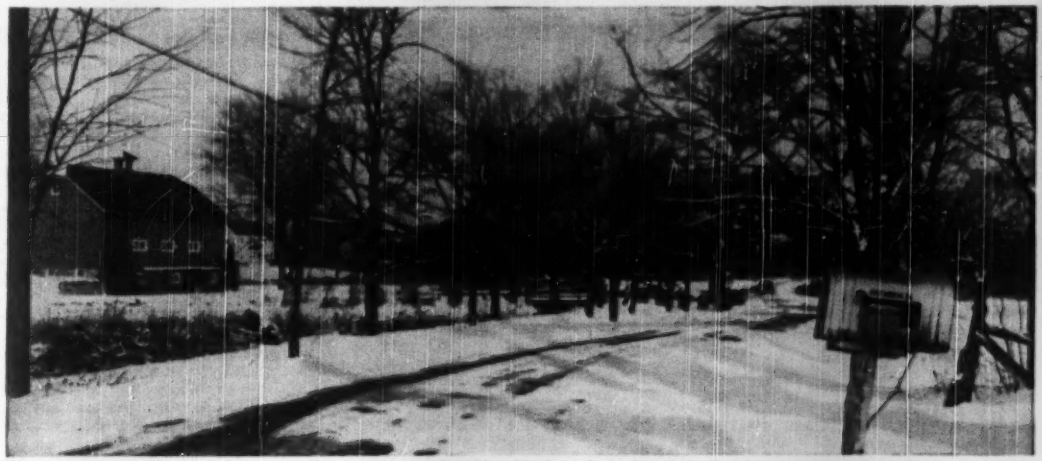
ANNUAL CONVENTION
New York, N.Y., October 22–25
(Board of Direction meets October 20–21)

News of Local Sections Briefed

SECTION	DATE	ATTENDANCE	PROGRAM
Central Ohio	Sept. 14	22	Inspection trip to Columbus Sewage Treatment Plant, where prestressing operations during construction of sludge digestion tanks were viewed.
Colorado	Sept. 11	56	Dinner meeting. "Engineering in Foreign Countries" was discussed by William Collins, with Earth Dams Section of Bureau of Reclamation; Warren Simmonds, head, Special Assignments Section, U.S.B.R.; and Bruce Johnson, with R. J. Tipton & Associates.
District of Columbia	Sept. 12	...	Joint meeting with Washington chapter of American Society of Landscape Architects, featuring discussion of Washington-Baltimore Parkway.
Duluth	Sept. 18	16	Business meeting with discussion of Society activities.
Florida			
Gainesville Sub-Section	Oct. 17	...	Dinner meeting. ASCE Director Edmund Friedman talked on the EJC report on National Water Policy.
Georgia	Oct. 6	...	Luncheon meeting featuring William N. Cox, Jr., professor and head of department of safety engineering, Georgia Institute of Technology, as speaker.
Illinois	Oct. 6	...	L. F. Harza, Chicago consultant, spoke on India.
	Oct. 20	...	Extension of Chicago parks was described by Ray S. Knapp, planning engineer for Chicago Park District.
	Oct. 27	...	Luncheon meeting with G. J. Thon speaking on the role of the engineer in the civil defense of Great Britain.
Intermountain	Sept. 15	29	Dinner meeting featuring Alvin G. Pack, as speaker.
Los Angeles	Sept. 13	133	Panel discussion on "The Water Situation in Los Angeles" with Meyer Kramsky, associate hydraulic engineer, California State Division of Water Resources, acting as moderator. Other speakers included Paul Baumann, assistant chief engineer, Los Angeles County Flood Control District; L. E. Goit, engineer, Department of Water and Power of City of Los Angeles; and ASCE Director Julian Hinds, general manager and chief engineer, The Metropolitan Water District of Southern California.
Metropolitan	Oct. 18	...	A. D. Hunter, captain, CEC, USN, deputy chief, Bureau of Yards & Docks, Washington, D.C., presented a paper on civil engineering in the Navy.
Mid-South			
Jackson Branch	Sept. 27	26	Dinner meeting. Herrol J. Skidmore, director of Waterways Experiment Station, talked on military construction in Okinawa.
Oklahoma	Sept. 15	27	Fall meeting. ASCE Director Webster L. Benham reported on Society affairs.
Philadelphia	Oct. 10	...	Joint inspection trip to public works projects in Philadelphia with Metropolitan-Philadelphia chapter of American Public Works Association. Evening meeting speaker was R. A. Gilmore, project engineer, J. E. Greiner Co., Baltimore, Md., who described new bridge over Chesapeake Bay at Stevensville and Sandy Point, Md., now under construction.
Sacramento	Aug. 1	95	J. E. Jellick, manager of Portland Cement Information Bureau, spoke on concrete.
	Aug. 8	56	Anthony J. Kennedy, legislative counsel for California Legislative Council of Professional Engineers, outlined Council activities.
	Aug. 15	...	E. Combatalade, with Sacramento Municipal Utility District, described the district.
	Aug. 29	89	Howard B. Blodgett, professor of civil engineering, University of Nevada, talked on timber.
Texas			
Corpus Christi Branch	Aug. 17	...	Jeff Bell, manager of Corpus Christi Chamber of Commerce, discussed master development plan for city.
Brazos County Branch	Sept. 13	...	Election of officers—James B. Baty, president; Joe A. Orr, Sr., vice-president; and Clyde C. Franklin, secretary-treasurer. R. L. Peurifoy will serve as reporter of the Branch for *The Texas Engineer*.

COME SUMMER'S SUN . . . OR WINTER'S COLD

Even under the hottest summer sun, roads built with TARVIA* road tar are glare-free and restful on the eyes. They take the strain out of driving. Self-healing, they stay smooth for easy riding. They will not wave, roll, push, or bleed.



Winter's snow and ice melt faster, thanks to the heat-absorbing black surface of roads built with TARVIA road tar. Snow removal is facilitated. And, furthermore, neither calcium chloride nor sodium chloride has any adverse effect on TARVIA road tar surfaces.

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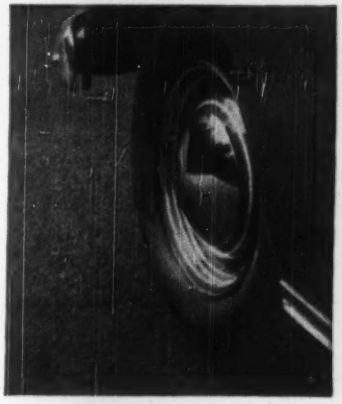

The slightly granular, "tractionized" surface of a road built with TARVIA road tar gives tires a better grip.

Barrett Tarvia* ROAD TAR

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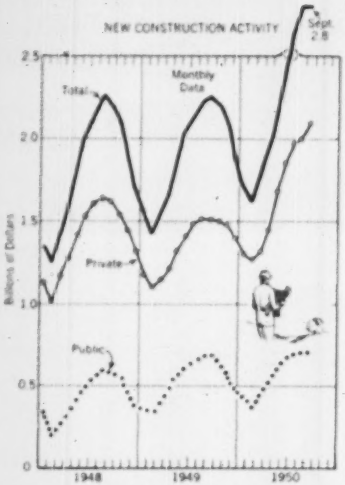
NEWS

Industrial Building Swells Construction Volume

INCREASED INDUSTRIAL BUILDING was the outstanding feature of construction activity in September, according to a joint release of the Construction Division of the Department of Commerce and the Department of Labor's Bureau of Labor Statistics. Industrial building reached an estimated $1.01 million, the highest monthly total since early in 1949 and an increase of 46 percent over the September 1949 level, the joint agencies state.

The total volume of new construction put in place during September amounted to nearly $2.8 billion, an increase of 1 percent above the August total and of 26 percent over the September 1949 total. Private residential building showed further expansion and highway construction advanced contra-seasonally. Increases in warehouse and office building activity are also reported, with most other types of nonresidential building beginning to level off seasonally.

The construction total for the first nine months of 1950 was more than $20 billion, according to the joint release. Private outlays for new construction came to $15 billion, 27 percent more than during the corresponding period of 1949, while public construction expenditures totaling $5 billion were 8 percent above last year. Most of the increase in total private investment in new construction is attributed to the private homebuilding boom, and new schools, highways, and conservation work are said to account for the bulk of the increase in public construction expenditures.



DEPARTMENT OF COMMERCE CURVES show record heights in September construction volume.

Civilian Defense Problems Spotlighted at Public Works Congress

CIVILIAN DEFENSE AND its attendant public works problems occupied the attention of 1,000 engineers and administrators in the public works field attending the 50th Annual Congress and Equipment Show of the American Public Works Association, which was held in New York City October 15-18. Top officials in the New York State and City civil defense commissions and the Chicago civil defense organization answered questions vital to public works administrators. The close coordination necessary between public works and civilian defense was also emphasized in technical sessions on public lighting, refuse disposal, air pollution, and other subjects.

In a resolution directed to President Truman and the state governors, the organization urged that materials for public works construction and maintenance receive top priorities on the ground that "the healthy functioning of our cities is essential to civil defense and the preservation of democratic life," and that "smooth and efficient public works are mandatory to the proper functioning of the cities."

Radiant heating may eventually make icy pavements a thing of the past, Frederick W. Crane, M. ASCE, public works commissioner of Buffalo, said in a roundtable session on snow removal and ice control that attracted much attention. Mr. Crane cited recent successful use of the method by the Oregon and Michigan highway departments.

Remarkable results achieved in Pittsburgh's program for control of air pollution were outlined at another session by James S. Devlin, Pittsburgh director of public works. Mr. Devlin attributed the city's "phenomenal success in cleaning its air" to five measures that might easily be applied to other smoke-abatement programs. These are a dieselization program on railroads and rivers; modernization and renovation of heating installations; and use of mechanical equipment, including fly-ash collectors, automatic control panels, and the electric eye for spotting smoking installations. Most important of all, he emphasized, is the spirit of civic cooperation.

Equipment needed to implement various technical programs outlined was on display at the Ninth Regiment Armory, where more than sixty manufacturers of materials and equipment had booths.

In the closing session of the Congress, Milton Rosen, commissioner of public works of St. Paul, Minn., was elected president of the Association succeeding W. O. Jones, M. ASCE, city manager of Fort Worth, Tex. W. A. Coolidge, M. ASCE, director of public works for Nashville, Tenn., was elected a district vice-president.

Building Research Group Schedules Second Meeting

"FIRE RESISTANCE OF Non-Load-Bearing Walls" is the subject announced by the Building Research Advisory Board for its second Research Correlation Conference, to be held in the National Academy of Sciences Building, Washington, D.C., on November 21. In announcing the all-day conference, William H. Scheick, executive director of BRAB, said that the subject was chosen because of its importance to research in new principles of design, engineering, and construction dealing with "curtain-wall" construction in large buildings, which creates new problems in connection with testing procedures and criteria upon which codes and regulations are written.

Engineers interested in attending should write to the Building Research Advisory Board, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D.C., requesting registration blanks.

Navy to Increase Aircraft Rocket Production Facilities

NAVY FACILITIES FOR increasing aircraft rocket production at the Naval Ordnance Depot at Shumaker, Ark., will be expanded with the award of a $35,000,000 Navy contract to the four combined contracting firms, which handled the original construction project at Shumaker during World War II. The firms are Winston Brothers Co. and C. F. Haglin & Sons, Inc., Minneapolis, Minn.; Missouri Valley Constructors, Leavenworth, Kans.; and the Sollitt Construction Co., Inc., South Bend, Ind.

The new facilities will add production lines for the assembly and loading of aircraft rockets to meet the needs of the Navy, Air Force, and Marine Corps. The present contract also covers completion of production buildings, personnel structures, utilities, railroads, additional magazines, and grading and drainage. Work will start immediately, with completion expected in a year.

STUDIES FOR PROPOSED BRIDGE across Straits of Messina between Italy and Sicily have been made by D. B. Steinman, M. ASCE, New York City bridge designer and engineer. Projected structure, shown here in artist's rendering, would be the longest suspension bridge in the world over one of the most difficult crossings ever considered. Legendary site of the Scylla and Charybdis, crossing is 2 miles wide with depth of 400 ft for the entire distance. Other factors contributing to technical problems involved in project are swift current, heavy tides, and frequent wind and storm. Carrying both a railroad and highway, proposed bridge will require 5,000-ft main span and two side spans of 2,300 ft each. Estimated cost is $60,000,000.

New York Engineers Make Puerto Rico Airport Study

THE PUERTO RICO Transportation Authority has retained the services of the Knappen, Tippetts, Abbett Engineering Co., of New York, for the design of terminal buildings, facilities, and services for the new Puerto Rico International Airport. The survey will include an initial traffic forecast, space analysis report, and a master plan for development of buildings and facilities. Consulting architects on the project will be the Puerto Rican firm of Toro, Ferrer and Torregrosa.

Chamber of Commerce Calls Conference on Urban Problems

IN THE BELIEF that businessmen can play a decisive role in helping their communities solve today's pressing problems of overcrowded streets and slum areas, the Chamber of Commerce of the United States has scheduled a nationwide Businessmen's Conference on Urban Problems for November 20 and 21 in Washington. Co-sponsors are the Chamber's Construction-Civic Development and Transportation-Communication departments, assisted by a special advisory committee of authorities concerned with community problems. Discussion panels of businessmen, expert technicians, and municipal, state, and federal officials will be a major feature of the two-day program. Subjects for study include street traffic and parking, public transit, urban redevelopment, urban truck transportation, expressways, zoning, and city planning.

A similar conference held in Washington in 1947 drew an attendance of almost 600.

Says Inadequate Mapping Handicaps Defense Effort

INADEQUATE TOPOGRAPHIC MAPPING of many parts of the country will handicap the national defense effort, Secretary of the Interior Oscar L. Chapman stated recently in announcing publication of two maps showing the status of federal topographic mapping in the United States. Only about 10 percent of the country is now mapped to fully adequate standards, the status maps show, while another 15 percent is covered by maps which although deficient in some respects are still usable for most needs.

During World War II, lack of satisfactory maps hampered numerous defense activities, Secretary Chapman said. "Inadequate mapping increased the difficulties of making reconnaissance surveys in connection with location of military installations and war plants, retarded exploration for new mineral deposits, and in other ways slowed down the country's war effort," he added.

Adequate topographic maps cover all of Massachusetts, Rhode Island, and Puerto Rico, the status maps reveal. It is expected that Connecticut will be completely mapped by 1953 and Kentucky by 1955. States in which mapping has been completed, but in which a majority of quadrangles need revision include New Hampshire, New York, Pennsylvania, New Jersey, Delaware, Maryland, West Virginia, and Ohio.

Both status maps and a descriptive folder on the topographic map series are available without charge from the Map Information Office, Geological Survey, Washington 25, D.C.

International Center for Structural Information Sought

A COMMITTEE REPRESENTING the United States membership of the International Association for Bridge and Structural Engineering is investigating the possibility of establishing an international contact or exchange center of information for structural engineers of all countries working on the same or related problems.

Under the chairmanship of L. Coff, M. ASCE, consulting engineer of New York City, the committee is considering all possible avenues through which such a center can be set up, including the United Nations and governmental and private organizations, and invites suggestions from outside agencies and individuals. The committee states that initiation of such a center "should provide an interesting manifestation of the strong bonds of good will existing among technical men throughout the world." Suggestions may be sent to Mr. Coff at 198 Broadway, New York 7, N. Y.

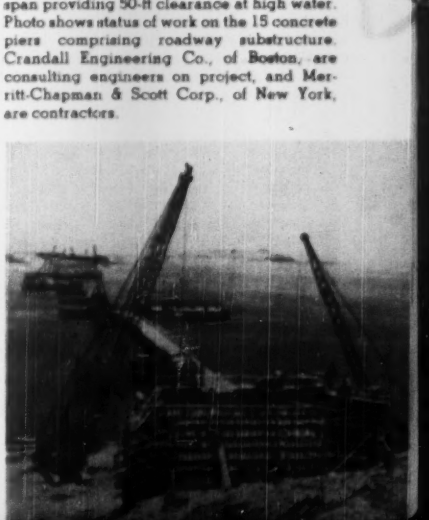
Since its formation in 1929 the International Association for Bridge and Structural Engineering has already proved an efficient clearing house for structural knowledge and research all over the world. The international character of its membership and the variety of conditions facing its members give special value to its publications and reports. The most recent congress of the Association was held in Liege, Belgium, in 1948.

With headquarters in Zurich, Switzerland, the Association functions on a national basis in the various countries represented. The U.S. Council, under the chairmanship of D. B. Steinman, M. ASCE, reports that a recent sharp upswing in membership brings the total in the United States to almost 200 and establishes it as the largest national contingent in the organization. "This," the U.S. Council states, "is a tribute to the growing consciousness on the part of American engineers of the importance of the international aspects of their professional work, and of the many advantages which accrue from international cooperation."

U.S. Railroad Methods Studied by Japanese

SHIGEMI TANAKA, CHIEF engineer of the Japanese National Railways, Tokyo, is one of several distinguished foreign engineers recently visiting ASCE Headquarters during a tour of United States engineering projects and methods. Mr. Tanaka is interested in methods of railroad construction and maintenance, railroad electrification, and rolling stock. American procedures for doing public works by contract are being studied with special interest by foreign engineers.

WORK ADVANCES ON 3,900-ft Boston Viaduct that will link Long Island in Boston Harbor with Massachusetts mainland at Squantum. Built for Boston's Institutions Department, the $2,600,000 two-lane project will provide first highway route between mainland and island, on which city's hospital is located. Project will consist of through-truss-span bridge with 250-ft center span providing 50-ft clearance at high water. Photo shows status of work on the 15 concrete piers comprising roadway substructure. Crandall Engineering Co., of Boston, are consulting engineers on project, and Merritt-Chapman & Scott Corp., of New York, are contractors.



Use of Prestressed Concrete for Railroad Bridge Slabs Tested in PCA Laboratories

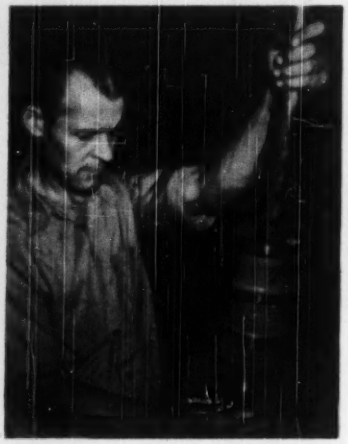
FIRST TESTS ON a prestressed concrete railroad trestle slab approximately one-half the depth of a conventional reinforced concrete slab of the same length and width, which was loaded to failure in the Portland Cement Association's new Research and Development Laboratories near Chicago on September 20, are reported by G. Donald Kennedy, M. ASCE, consulting engineer and assistant to the president. In the tests a full-size slab 25 ft long, 7 ft wide, and 1$^1/_2$ ft deep, designed for an E-72 live load plus full impact, withstood a load of 480,000 lb before failure—the equivalent of approximately 2.8 times live load and impact.

The slab, which was built in the PCA laboratories in cooperation with the Association of American Railroads and the John A. Roebling's Sons Co., weighed 20 tons and contained 10 cu yd of concrete with a strength of 7,000 psi at 28 days. Prestressing was done with 15 bridge strands 1$^1/_4$ in. in diameter, post-tensioned to 120,000 psi.

In the test procedure, a strand and socket connection was tested in a 400,000-lb-capacity testing machine. It was found that a tensile force of 255,000 lb, or 228,000 psi, was required to break the strand, which was composed of thirty-seven 5-mm steel wires of high tensile strength encased in a plastic tubing. At the test load there was no evidence of failure of the end connections.

The prestressed slab was loaded to full design load in the 1,000,000-lb-capacity compression-testing machine. The load was then increased until the first hairline crack appeared at approximately one and a half times live load and impact. Upon removal of the load the crack disappeared entirely, indicating the complete elasticity of the slab. Finally the slab was loaded until failure occurred in the upper portion at approximately 2.8 times the design load. Each time the load was increased, readings of the 100-odd strain gages located throughout the slab were read at a central "switchboard" especially developed for the tests. Deflections of the slab were also noted.

Before the start of construction of the Walnut Lane Bridge in Philadelphia late last year, the use of prestressed concrete had been confined almost entirely to England and western European countries. A loading test of a 160-ft-long prestressed concrete girder, carried out in Philadelphia in October 1949 prior to construction of the bridge, was the first public test of its type in the United States. (October 1949 CIVIL ENGINEERING, page 74.)



BRIDGE STRANDS ARE LOWERED into position in form for railroad trestle slab (left view) in recent tests to failure at PCA laboratories. Method of securing strand sockets in end plates can be seen at lower right in same photo. Strands were post-tensioned to 120,000 psi by means of hydraulic jack. Right-hand photo shows strand and socket connection used in prestressing concrete railroad trestle slab.

Austria Builds Mammoth Hydroelectric Storage Plant

ONE OF THE largest electric storage plants in Europe is being built with Marshall Plan funds in the Austrian Alps at Kaprun. Designed as an emergency power source for the whole of Austria and ultimately for all Central Europe, the project will have an annual output of 600,000,000 kwhr. Of this total, 400,000,000 kwhr will be available in the winter when other electric supplies are low. Another prime advantage of the installation is that, by using stored rather than falling water, it can supply power almost instantaneously where it is needed and switch it off when it is not needed.

Utilizing glacier-fed lakes some 6,000 ft above sea level, the Kaprun project will include three reservoirs, five dams, and two power stations. Despite the construction difficulties arising from the inaccessibility of the site and extremely bad weather that limits work to seven months of the year, construction of the 1,100-ft-long Limberg Dam and Mooserboden Reservoir is about two-thirds completed. From the dam, water will flow through a 4$^1/_2$-mile pressure tunnel to the top of a mountain, from where it will drop through penstocks nearly half a mile to the power station at Kaprun.

Initial Marshall Plan appropriations for the project total $12,000,000, and a supplementary appropriation of $10,000,000 is planned. Completion of the entire project is scheduled for 1954.

Minneapolis Initiates Off-Street Parking Garage Program

TO MEET THE problem of increased traffic flows and shortage of parking facilities in its downtown business district, the City of Minneapolis, Minn., is planning construction of three multi-level off-street parking structures with a combined capacity of 1,800 cars. The present program is based on recommendations of National Garages, Inc., parking consultants of Detroit, Mich., who have been making a long-range study of the city's traffic situation at the request of its Parking Technical Committee.

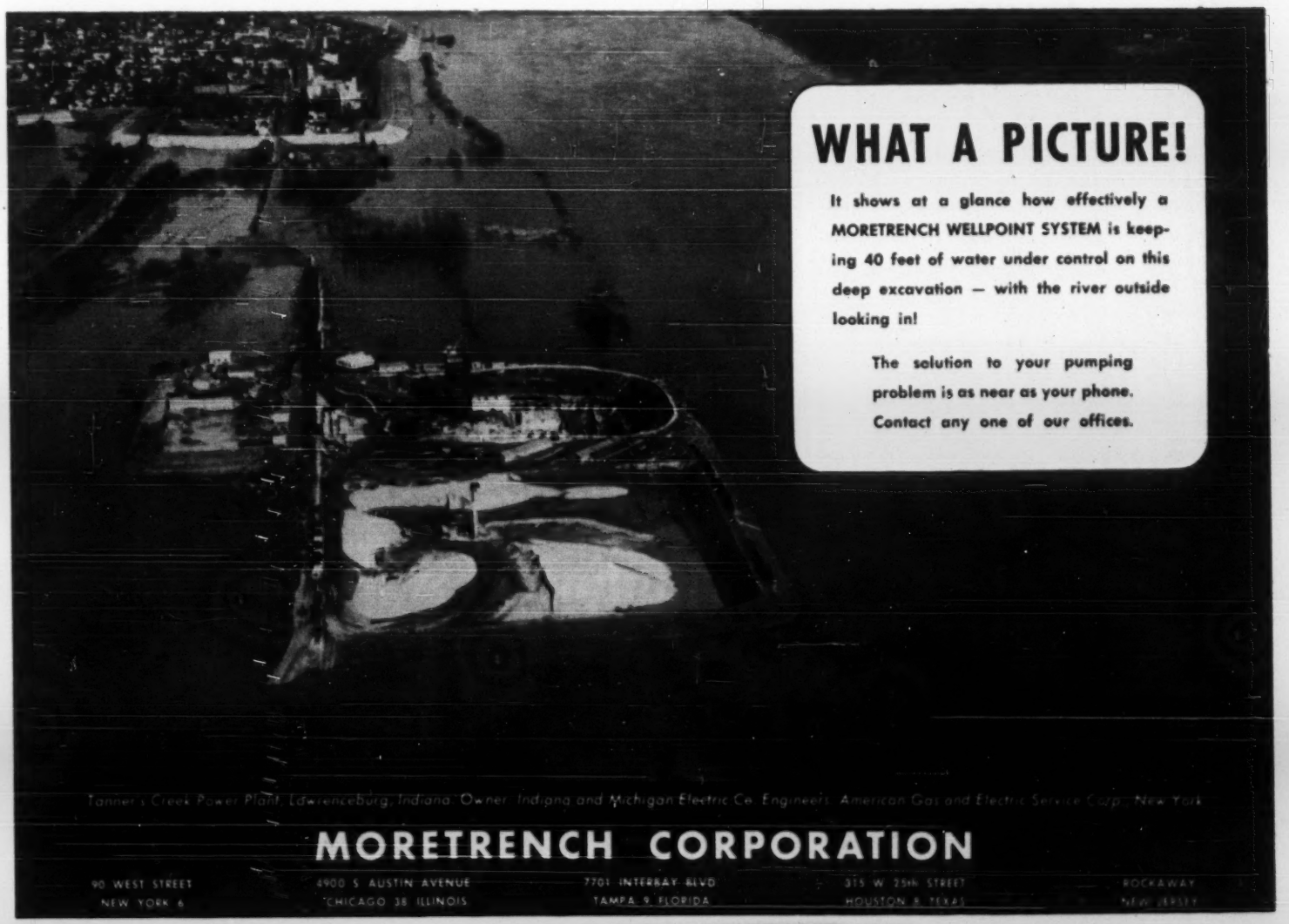
The parking structures, to be started in November, are of the open type with six parking levels. Floors will be of reinforced concrete, and columns of structural steel encased in concrete to conserve floor space. Design and construction of the $3,200,000 project are being handled by the Detroit consulting engineering firm of D. L. Briegel and Associates and Larson and McLaren, Minneapolis architects.

The project is financed by Downtown Auto Park, Inc., a group of downtown property owners and business firms, by means of a bond issue and a mortgage loan.

Army Engineers Announce Civil Works Allocations

RIVER AND HARBOR IMPROVEMENT and flood-control activities of the Corps of Engineers, which will be continued during the current fiscal year under a curtailed program screened to comply with defense criteria, are announced by Maj. Gen. Lewis A. Pick, Chief of Engineers.

The program allocates $430,527,150 for flood control and $186,142,500 for river and harbor work. Construction funds total $502,971,750. There is $340,394,750 in the flood control general program for 101 projects in 33 states, and $113,760,500 for 51 river and harbor projects in 30 states and Alaska. The Mississippi River and its tributaries flood control project is allotted $46,800,000 for construction, and $2,016,500 is available for construction work on the Sacramento River flood control project.



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Work Goes Forward on Baytown Tunnel Under Houston Ship Channel

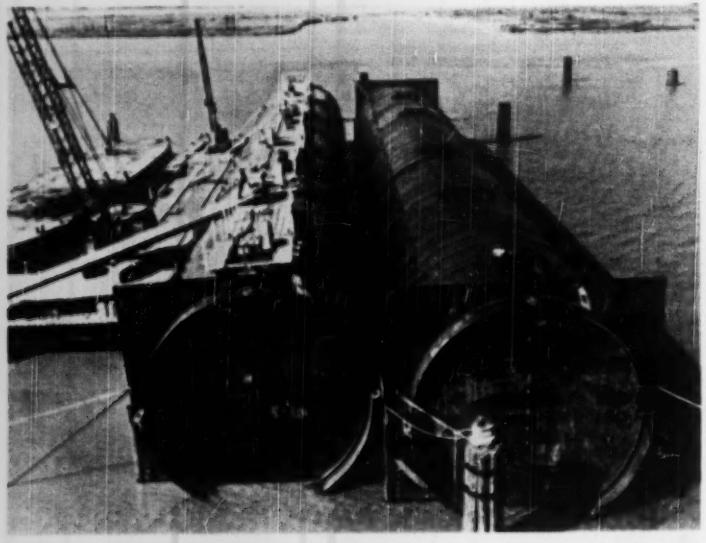
THE BAYTOWN TUNNEL, which is being built by the Texas Highway Department under the Houston Ship Channel, will constitute the Department's second vehicular roadway under the channel. The first, the Washburn Tunnel at Pasadena, Tex., north of the Baytown crossing, was completed this spring (see July issue of CIVIL ENGINEERING, page 28). Prefabricated in sections and floated to the construction site as was the Washburn Tunnel, the Baytown Tunnel differs from previous precast tunnel designs in that the circular shells are located on the outside of the reinforced concrete lining. This method permits more economical construction than the tubes of smaller diameter, lined with a thinner interior ring of reinforced concrete and covered with an outside layer of tremie concrete, which have been used in earlier tunnels.

Connecting Baytown on the north side of the Houston Ship Channel with La Porte on the south side, the Baytown crossing will consist of a four-lane highway on an earth embankment, interspersed with short trestle spans across Black Duck Bay on the north side and San Jacinto Bay on the south, and a subaqueous tunnel under the channel itself. Plans for the approach highways were prepared by the Texas Highway Department, and the New York engineering firm of Parsons, Brinckerhoff, Hall & Macdonald designed the tunnel and is supervising its construction.

The tunnel will have a portal-to-portal length of 3,000 ft, with open approaches 550 ft long on each side. The tunnel roadway will have a width of 22 ft between curbs and minimum overhead clearance of 14 ft. Exit lanes in the open approaches are being widened to provide space for two lanes of vehicles leaving the tunnel, while a single lane is provided for entering traffic. Nine precast sections (three 250 ft long and six approximately 300 ft in length) will comprise 2,557 ft of the tunnel length, and the remainder will be built by the cut-and-cover method of reinforced concrete construction. The ventilation building will be located on the north side of the tunnel.

A contract was let for the construction of the precast tunnel sections to Brown & Root, Inc., of Houston, Tex., in August 1949. It is expected that contracts covering the remainder of the project will be advertised in December. Brown & Root sublet the construction of the steel tubes to the Consolidated Western Steel Corp., at Orange, Tex., where the first section was launched last May.

From the shipyard in Orange, the general contractor is towing the sections a distance of about 100 miles to the construction site. In a bay dredged on the south side of the ship channel, the tubes are moored at a temporary dock and the concrete lining and roadway slab are poured while the sections are afloat. The first tube will be sunk in place early in November in a trench dredged across the channel by the Standard Dredging Co. It will rest on a foundation course of coarse sand, graded by means of a screed suspended from a floating rig. After several tubes have been placed, the joints between them will be sealed by tremie concrete and the interior bulkheads on the ends of the tubes will be removed from the inside.



CLOSE-UP OF TUBES A AND B AT CONCRETING DOCK indicates that forms and reinforcing are being placed in Tube A (at left), which is gradually sinking in water. Tube B (at right) is tied up after arrival from yards at Orange.

Material for this release was supplied by J. O. Bickel, M. ASCE, project engineer for Parsons Brinckerhoff, Hall & Macdonald consulting engineers for the work.

City Building Activity Reaches Postwar High

CITY BUILDING ACTIVITY was substantially greater in the first half of 1950 than in any similar period during the postwar years, according to preliminary estimates of the U.S. Department of Labor's Bureau of Labor Statistics. Urban building construction, as measured by building permits issued and federal contracts awarded, was valued at $5 billion in the first half of the year, an increase of 28 percent over valuations for the first six months of 1949. New housing accounted for 63 percent of the dollar volume of all urban building construction authorized during the period, with permit valuations for new homebuilding totaling over $3.1 billion, 72 percent above the amounts reported in the corresponding months of 1949.

All regions of the nation scored increases in urban building valuations this year over the same six-month period in 1949. The East North Central region ranked first, with valuations totaling over $1.1 billion, and the Middle Atlantic region was second with $828 million. However, city building in the West North Central region showed the greatest proportionate increase over the first six months of last year—81 percent to $405 million. California, Texas, and New York were the top-ranking states in that order, and Los Angeles and New York (each with nearly $190 million) were the top-ranking cities during the period. Chicago ($125 million) and Detroit ($115 million) were in third and fourth place.

Foreign Engineers Finish Study of U.S. Highways

HIGHWAY OFFICIALS AND engineers from 18 foreign countries completed a three-month course of training in theory and practice of highway improvement and utilization in the United States on September 1. The course, including a three-week bus trip to observe construction and maintenance in the field, was conducted by the Bureau of Public Roads. Cooperating agencies were the Department of State, the Department of Commerce, the Economic Cooperation Administration, and the foreign governments involved.

Praise for the course was expressed at the closing session by Andre Saccasyn, chief engineer of the Ministry of Public Works of Belgium, who commented on the fact that, "Nothing was hidden from us at any time; we saw both the successes and the failures. Everything was discussed with us frankly. . . . It was a convincing experience indicating that an international mind does exist with mutual understanding, freedom of thought and expression, and respect for each other's convictions."

Welded Design Cuts Structural Cost 32%

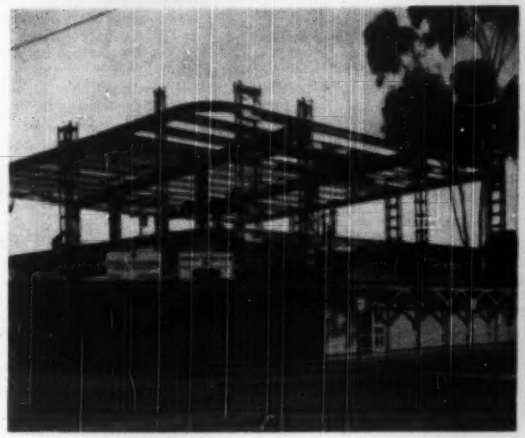


Fig. 1. *All welded (112 ton) framework for the Associated Telephone Company Building, Laguna Beach, California.*

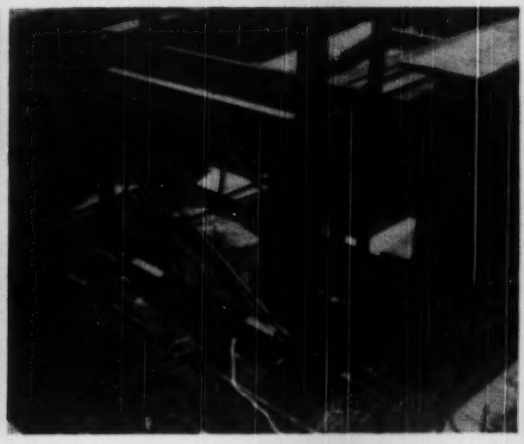


Fig. 2. *Open box column construction fabricated at low cost from plain angles, plate and bars.*

By **Maurice Sasso, Consulting Engineer**
Los Angeles, California

ARC welding provides the engineer new freedom in design for developing structural members impossible by any other method. It enables him to use structural materials more efficiently, to design stronger, yet lighter buildings that can be erected at lower cost.

In the construction of the Associated Telephone Company Building, Laguna Beach, California, open box column design has effected a saving of 32%. The saving of welded construction over riveted design amounts to $7,954 and includes the elimination of 27 tons of structural steel and a reduction in building height of 1'6".

All open box column members, (Fig. 2) as well as beams and girders, were shop fabricated at low cost with fast, downhand welding methods. Field erection was completed in only 26 hours with a crew of 6 men. Both shop and field welding were done with Lincoln "Fleetweld 5" electrode and "Shield-Arc" welders. Welding also made it possible to erect the addition without disturbing delicate instrument settings in the telephone exchange itself.

Fig. 3. *Arc welding girder-to-column. This is the only weld where a scaffold was used.*

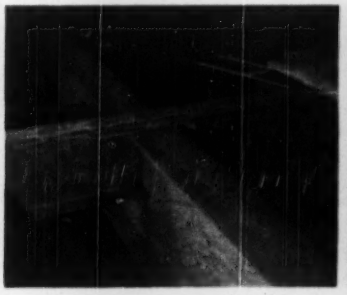


Fig. 4. *Welding beam-to-girder. Full continuity increases resistance to bending and shear.*

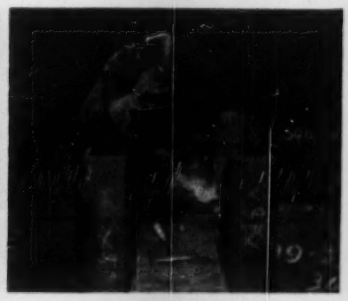


Fig. 5. *Beam and girder connection made through open box column permits easy downhand welding.*

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National Council on Soil Mechanics Is Established

RECENT FORMATION OF the United States National Council on Soil Mechanics and Foundation Engineering is announced by A. E. Cummings, M. ASCE, chairman of the executive committee. A member organization of the International Society of Soil Mechanics and Foundation Engineering, the National Council will represent the United States in affiliation with the International Society in promoting cooperation among engineers and scientists and in encouraging the "interchange of knowledge, ideas, and the results of research and practical experience in the sphere of soil mechanics and its practical applications." The newly formed group will also cooperate in the holding of international congresses and in compiling annual reports reviewing the contributions to soil mechanics made in the United States during the year.

The Council was organized under the sponsorship of the ASCE Soil Mechanics and Foundations Division, and the sponsorship was approved by the Board of Direction at its Toronto meeting in July.

Inquiries concerning membership in the Council may be addressed to Mr. Cummings, Room 1308, 140 Cedar Street, New York 6, N.Y.

Army Seeks Engineers to Fill Posts in Alaska

THE ALASKA DISTRICT of the Corps of Engineers is in urgent need of professional and subprofessional engineering personnel in order to accomplish its military construction program under the heavy schedule required for adequate military defense, according to an announcement from the North Pacific Division of the Army, which has been assigned the task of recruiting the required personnel. A large number of unfilled requisitions are now on hand, according to Frank L. Cole, chief of the Personnel Branch.

Full information on living and working conditions in Alaska is available. All inquiries should be addressed to the Division Engineer, North Pacific Division, Corps of Engineers, 500 Pittock Block, Portland 5, Oreg.

Los Angeles Lets Contract for Big Underground Garage

CONSTRUCTION OF A $5,000,000 parking garage under Pershing Square in Los Angeles is about to begin, with award of a Recreation and Park Commission contract to City Park Garage, Inc. The project, which has been discussed for a number of years, is scheduled for completion by the end of 1952. Designation of the garage as a possible bomb shelter is expected to eliminate difficulty in obtaining materials.

According to the specifications the park surface must be restored to its existing condition after construction is completed.

Traffic Engineers Hold Annual Meeting in N.Y.C.

TRAFFIC PROBLEMS, WHICH everywhere are growing more pressing and more complex, were discussed in speeches and panel sessions by experts from all over the country at the recent 21st annual meeting of the Institute of Traffic Engineers in New York. Among those addressing the convention were Commissioner Lloyd B. Reid, M. ASCE, head of the newly created New York City Department of Traffic, and Deputy Commissioner Roy Jorgenson, M. ASCE, of the Connecticut Highway Department. Lee C. Webb, bus terminal superintendent for the Port of New York Authority, discussed the Authority's new $24,000,000 union bus terminal now nearing completion in midtown Manhattan.

Wilbur S. Smith, Assoc. M. ASCE, associate director of the Yale Bureau of Highway Traffic, is current president of the Institute, and Robert S. Holmes, Assoc. M. ASCE, of New Haven, Conn., is executive secretary. Headquarters for the organization are located in New Haven.

American Engineer Studies Prestressing of Structural Steel

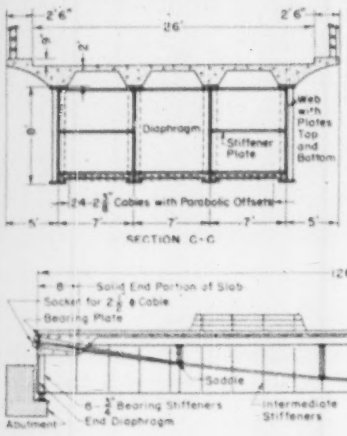
EUROPEAN INVESTIGATIONS OF the feasibility of applying prestressing principles to structural steel have been reported (CIVIL ENGINEERING for September, page 76). Early studies by United States engineers on the possibility of prestressing structural steel, timber, and light-weight materials such as aluminum and magnesium are noted by L. Coff, M. ASCE, New York City consultant connected for many years with the John A. Roebling's Sons Co.

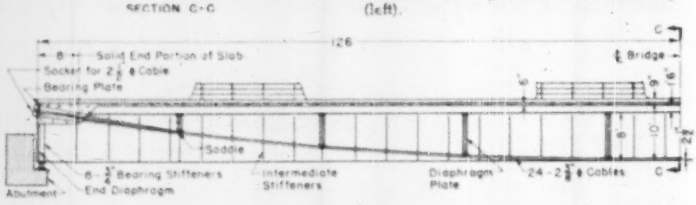
Prestressing consists of inducing in a structure initial stresses opposite in sign to the ones expected from the design loads. If a beam is arched by a tie-member attached to the ends and tightened by a turnbuckle, tension is produced on top and compression at the bottom. These stresses are the opposite of those induced by the subsequent loadings. Other advantages of prestressing, especially for steel and light metals, are the control of deflection and buckling. For reducing the buckling length, additional contact points can be selected between beams and cables.

In the past decade, Mr. Coff has examined the use of wire cables to stress materials other than concrete and has recently been granted a patent for a method which is based on supporting steel beams by underslung wire cables, tensioned and anchored to the ends of a steel girder and to a slab concreted on top. He reports that the upward forces induced by the tensioning of these cables, sloped upward toward the ends, will relieve load moments. By arching the structure, the direction of the horizontal shear between concrete and steel is reversed. This shear will become zero, when the upward forces produced by the tensioned cables balance the downward forces due to loads. A composite section results automatically.

If the cable offsets are located along a parabola, it is possible to obtain for equally distributed loads a horizontal strut free of bending and shear and with zero deflection. For taking the thrust of the cables the concrete slab could play an important part. A strut condition, however, may not always be desirable, depending on spans and loads. In any case, as a result of the relief at the bracing points by the upward cable reactions, the bending moments from downward loads are very much reduced. In many instances, it is possible to utilize rolled sections beyond their present span limits and still stay within allowable stresses.

In Figs. 1 and 2, a two-lane 250-ft plate-girder underslung-cable bridge, designed for H-20 loading by Mr. Coff, is shown in half longitudinal section and in cross section. The depth of 10 ft, 1/25 of the span, could be further reduced if necessary. A reduction of this ratio would not necessarily increase deflection Mr. Coff states, but can be fully controlled by the tension in the cables. The total structural steel requirement for the two-lane bridge is 225 tons, or about 60 psf. To this must be added 24 Roebling 2½-in. stranded galvanized bridge cables, with the necessary fittings. Encasing the steel structure would add to the dead load and increase the cost, without making it prohibitive in comparison with other types of structures.





FIGS. 1 AND 2 show drawing of 250-ft underslung cable bridge for H-20 loading. Half longitudinal section showing girders and cables is represented in Fig. 1 (below) and cross section of girders and cables in Fig. 2 (left).

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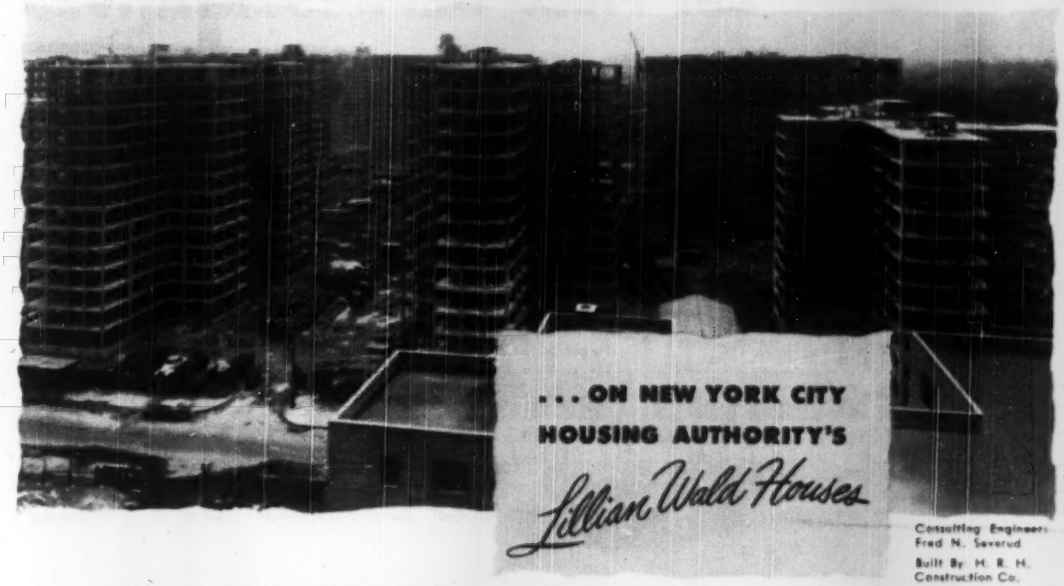

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When this huge project was being planned, the New York City Housing Authority had two alternate designs prepared—one with reinforced concrete framing, the other with structural steel. The lowest reinforced concrete bid was *$880,000 less* than the lowest bid using structural steel. Consequently, reinforced concrete was used for all 16 buildings.

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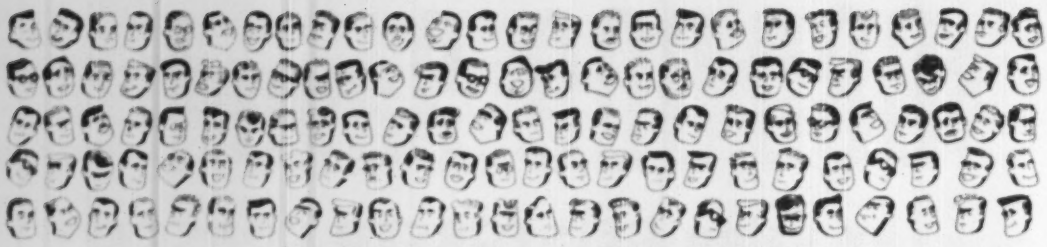

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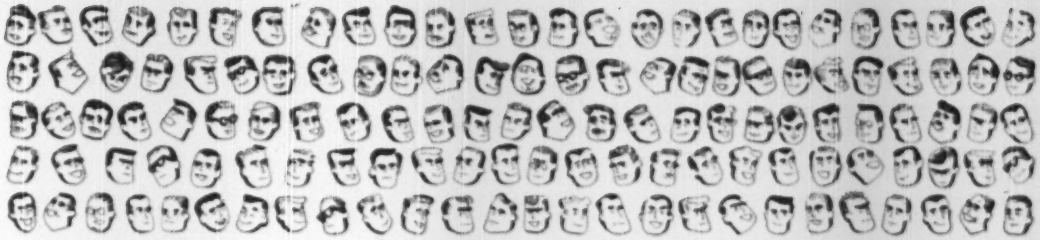

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India Plans Six-Year Development Program

A SIX-YEAR DEVELOPMENT plan, involving an expenditure of about $3,864,000,000, is announced by the Government of India in a recent *Economic News Letter* issued by the Indian Embassy. Nearly $1,701,000,000 will be needed in external aid in carrying out the plan, which will allot $1,008,000,000 for railways; $840,000,000 for major irrigation and multi-purpose projects of the state and central governments; $378,000,000 for government and other industrial measures; $420,000,000 for social and welfare development and $157,500,000 for rehabilitation.

Reporting on progress in the Indian Union, the *Economic News Letter* states that production of power has doubled in the past ten years, increasing from 2,440 million kwhr in 1939 to more than 4,900 million kwhr in 1949. The total installed capacity of all generating stations in the country reached nearly 1.54 million kw in 1949, with marked progress noted in rural electrification. Nearly two-thirds of the electric power sold in 1949 was consumed by industry, with textile and jute mills continuing to be the largest purchasers. Seven state electric-supply projects commenced operation during the year.

Engineers Advise State Control of Water Resources

ORGANIZATION OF MORE than 1,400 engineers of the Pacific Northwest into a group that will seek to foster state control of local and regional water resources is announced by F. R. Schanck, M. ASCE, consulting engineer of Portland, Ore., who heads the organization. The group, which is called "Independent Engineers for Private Enterprise," excludes engineers in the employ of federal agencies or public utilities.

In a statement before the President's Water Resources Policy Committee, an IEPE committee urged that Congress refrain from enacting detailed or restrictive laws relating to water resources because the importance of the resources varies widely in different parts of the country. The committee expressed the opinion that federal legislation touching on bodies of water wholly within a state is unwise. Regarding interstate waters, it recommended that Congress consider only legislation contributing to wise and efficient control of local and regional water resources by the states.

Other actions of the group include the drafting of a "Columbia River Basin Compact," which has been submitted to the governors of the seven Basin states. The basic idea of the compact, which envisages an agency on the order of the Colorado River Commission or the Port of New York Authority, is that the states have the right to solve problems arising from development of national resources by independent and cooperative action.

The group includes J. C. Stevens, Past-President of ASCE, and former Vice-President John W. Cunningham.

Meetings and Conferences

American Society for Engineering Education. Headquarters for the joint fall meeting of the Engineering College Administrative Council and the Engineering College Research Council of the American Society for Engineering Education will be the Hotels Carlton and Statler, Washington, D.C., on November 16 and 17.

National Exposition of Power and Mechanical Engineering. New developments in the field of power will be presented at the 19th National Exposition of Power and Mechanical Engineering in Grand Central Palace, New York, November 27 to December 2, under the auspices of the American Society of Mechanical Engineers in conjunction with the society's annual meeting.

American Standards Association. "The Place of Standardization in Construction" will be featured at the 32nd annual national standardization conference of the American Standards Association at the Waldorf-Astoria, New York City, November 27-29.

R. Robinson Rowe, M. ASCE

"DO YOU REMEMBER," asked Professor Neare, "the classic about the Iowa lad who moved to California and had to learn arithmetic all over again because the problems were in oranges and oil wells and he had been taught sums in apples and fence-posts? Then watch out! Guest Professor Jenney asked you to work one in roosters."

"A timely warning," said Professor Jenney. "I knew Joe Kerr was raised on a chicken farm and I wanted to give him a break."

"I'll take it," laughed Joe Kerr, "if you're not implying that I was raised like poultry. At first I was dumb enuf to think you wanted us to solve the equations:

$$R + H = 79$$
$$r + h = 241$$
$$rR + hH = 10{,}000$$

in which R and H are the numbers of roosters and hens, and r and h are the respective prices per bird. But there are only three equations for the four unknowns. So then I remembered that in a well-kept coop polygamy should be of the tenth degree, so that there should be seven roosters and 72 hens. Maybe the two odd hens are the normal expectancy for spinsters or setters—I've forgotten the ratio."

"Joe wasn't so dumb," conceded Cal Klater. "His answer is wrong, but his equations are right and he gave me just the clue I needed to solve them. Eliminating H and h by substitution of values from the first two equations in the third,

$$241R + 79r - 2rR = 9039$$

and then solving for $2R$,

$$2R = 79 - \frac{961}{241 - 2r}$$

"Now, to avoid fractional roosters, the value of the indicated fraction must be a factor of 961, that is: ±1, ±31, or ±961, giving six tentative solutions: 39, 40; 24, 55; −441, 520. These are really three paired solutions for R and H or vice versa, so the last pair is eliminated by its negativity. Trying the first pair, I found that r and h would be 601 and −360, which isn't good poultry business. So I came to the meeting with two solutions, 24 and 55, and Joe's clue proscribing polyandrous poultry eliminated the 55. So there were 24 roosters."

"Quite so, Cal, and even so there was progressive jealousy, mayhem and murder until the H/R ratio approached 10. Any comment, Noah?"

"Only that the rooster is even more *persona non grata* in the new-deal coop producing sterile eggs. Speaking of corrals, or weren't we, Flo Ridan has such an interesting job that he's going to share it with us for our next problem."

"Let me explain it with a sketch, Noah. In a 41-yd square field there are three circular corrals with radii as shown, each tangent to or 3 yd from two sides of the field. I have to build two diametrically opposite gates in each corral so that at rodeo time a circular bull ring can be run thru all six gates. Can you figure it or draw it?"

[Cal Klaters this time: Anne Othernut (J. Charles Rathbun), Expee Goodrich, Ed. C. Holt, Jr., Stoop (John L.) Nagle, Verne Alexander, R. E. Philleo, Van Masce (J. S. Kendrick), Kum Pewter (Walter Steinbruch), George B. Richardson, Don'T (Donald Thayer), and Julian Hinds. Guest Professors Jenney and Ridan are Richard Jenney and Charles G. Edson.]

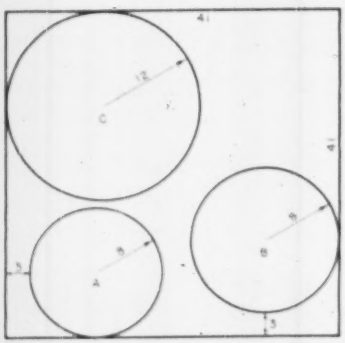

FIG. 1. CAN YOU DRAW the bull ring thru the three corrals?

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Construction view, State Office Building, Jackson, Miss. Architects: E. L. Malvaney & Assoc. Structural engineer: Harry Howe. Contractor: J. A. Jones Construction Company.

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REINFORCED concrete frame and floor construction offers both high quality and economy. A typical example is the State Office Building in Jackson, Miss. illustrated above, where it was considered the most economical high-grade construction for a building of this type and size.

Cost analyses and competitive bids throughout the nation show that savings up to 40% are made with reinforced concrete frames and floors.

Substantial savings in time result too. Frame and floor construction proceed simultaneously. Thus masons, plumbers, electricians and other tradesmen can do their jobs while the structural work progresses. Such construction meets all the requirements for flexibility in conduit layout.

Slab band floor construction, which was used in the State Office Building in Jackson, also permits a reduction in total building height. This saving is due to the elimination of the headroom required by conventional beams and girders in other types of construction.

Architects and structural engineers like the wide latitude and flexibility they have in locating partitions with slab band floors. The result is efficient use of total floor area.

Should you desire help in attaining quality concrete or the maximum structural advantages of reinforced concrete construction on any project our technical staff will be glad to assist you.

If you want more information about reinforced concrete frame and floor construction write for two free booklets: *"Continuity in Concrete Building Frames,"* and *"Handbook of Frame Constants,"* distributed only in the U. S. and Canada.

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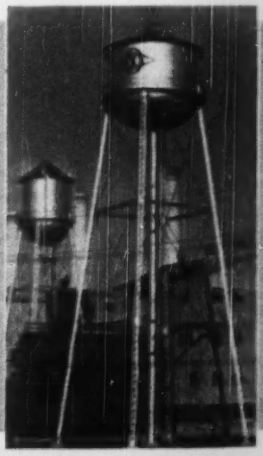

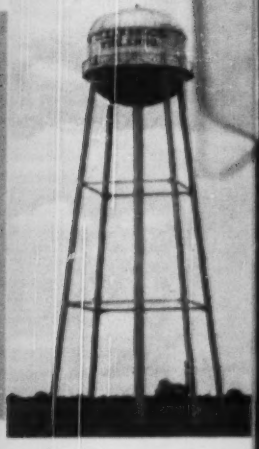

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NEW IN Education

A COURSE IN commercial engineering—a combination of basic technical training and business knowledge—has been initiated this fall at the University of Iowa, according to Dean Francis M. Dawson, M. ASCE. Offered as a supplement to regular engineering study, the new curriculum is given in the College of Commerce.

ADVANCED EVENING COURSES in highway planning and economics, traffic engineering characteristics, and highway and airport surfaces, are being given at the Institute of Transportation and Traffic Engineering of the University of California.

AN ANALYTICAL INVESTIGATION of impact on highway bridges was begun this summer at the Engineering Experiment Station of the University of Illinois. Its purpose is to provide a better theoretical basis for the planning of field tests and the interpretation of results obtained from such tests. Cooperating agencies are the Illinois Division of Highways and the Federal Bureau of Public Roads. The project is being conducted in the structural research laboratory of the civil engineering department, under the general direction of Dr. N. M. Newmark, M. ASCE, research professor of structural engineering.

RESEARCH FOR THE Southern Building Code Congress will be conducted by the Southwest Research Institute, San Antonio, Tex. Harold Vagtborg, Assoc. M. ASCE, president of the Institute, states that the Institute will analyze, and develop data on building materials, equipment, design, and techniques. Later the Code Research and Revision Committee of the Congress may base decisions for changes and improvements in the code on these reports.

THE NATIONAL BUREAU of Standards is using optical (microscopic) methods to determine what takes place during the early stages of the hydration of cement, particularly the first three days of curing. One of the major projects is to study the effects of integral additions of calcium chloride on cement hydration. The National Bureau of Standards, Committee 612 on "Curing of Concrete" of the American Concrete Institute, and the Calcium Chloride Association are joint sponsors. Harold F. Clemmer, M. ASCE, engineer of materials for the Division of Highways, of Washington, D.C., is project coordinator.

THE STATUS OF Indiana's ground-water resources will be considered at the first Indiana Water Conservation Conference, to be held at Purdue University on November 28 and 29. Discussion will cover geological and meteorological factors affecting water supply; current ground-water investigations; a federal water resources policy; the effect of population trends on domestic water usage; and the effects of excessive runoff and cyclic rainfall.

RECENTLY

Howard Earl Barnes (M. '50) Shreveport, La., city engineer, died there on September 9, at the age of 68. For approximately 45 years Mr. Barnes served the City of Shreveport, becoming assistant city engineer in 1902 and city engineer in 1918. Active in all major engineering projects of the city, he worked for many years on the urban expressway through Shreveport, which is still in the drafting stage. He also engaged in private practice. He was a regional member of the U.S. Public Works Association and a member of the Urban Highway Consultants board of directors.

Elmer Morton Fleming (M. '26) since 1949 assistant director of public relations of the New York State Department of Public Works, died at Mount Kisco, N.Y., on August 30. He was 61. For 15 years previously Mr. Fleming had been eastern district manager for the Portland Cement Association, with headquarters in New York City. He was a graduate of the University of Pennsylvania.

Burgess Manchester (Assoc. M. '24) consulting engineer, Metropolitan Utilities District, of Omaha, Nebr., died on May 25, according to word just received at Society Headquarters. His age was 57. Mr. Manchester worked for several railroads and the Koppers Co., and in 1920 became connected with the Metropolitan Utilities District. He was granted a leave of absence from the district in 1926 to conduct an industrial survey of the City of New Orleans, in connection with the introduction of natural gas.

William Howard Nelson (Assoc. M. '41) since 1934 senior court engineer for the engineering department of Seattle, Wash., died in Chicago, on September 13. He was 63. For some time Mr. Nelson was with the Chicago, Milwaukee & St. Paul Railway, lines west of Butte, Mont. Enlisting in the Signal Corps, Washington National Guard in 1903, he served on the Mexican border at Calexico, Calif. He later transferred to the Corps of Engineers, and was assigned to assist the War Department in acquiring land. Colonel Nelson was awarded the Legion of Merit for his service as labor relations officer on the staff of the Eighth Service Command, at Dallas, Tex., during World War II.

Albert William Newton (M. '05) who retired in 1937 as chief engineer of the Chicago, Burlington and Quincy Railway, Chicago, Ill., died October 10, at the age of 83. Upon his retirement Mr. Newton was retained as consulting engineer for the railroad. Earlier he had served the County Survey of Jersey County (Illinois), and the Chicago & Alton Railway Co.

Milan Owen Packard, Jr. (M. '48) for the past 16 years president of the Packard Contracting Co., Phoenix, Ariz., died in Los Angeles, on August 4, at the age of 65. Upon his graduation from the University of Utah in 1910, Mr. Packard entered the employ of the Utah Copper Co. He was then engaged by the Reynolds, Ely Construction Co., Springville, Utah, as secretary-treasurer. From 1917 to 1934 he practiced engineering under several partnerships in Salt Lake City, Los Angeles, and Phoenix. For many years he was a member of the board of directors of the Arizona chapter of the Associated General Contractors of America.

Charles Pearl Price (Affiliate '11) retired engineer of Boston, Mass., died recently, at the age of 77. Mr. Price served as vice-president of the American Tar Co. for 33 years. One of the earliest investigations in the use of bituminous materials for road construction and preservation was conducted under his supervision. He was a charter member of the American Association of Park Executives and a member of the American Roadbuilders Association and the New England Roadbuilders Association.

Orrin Randolph (Assoc. M. '11) civil engineer and developer, of West Palm Beach, Fla., and Asheville, N.C., died recently in Henderson, N.C., at the age of 68. Mr. Randolph received his engineering training at Colorado College. He moved to Florida in 1911 and became chief engineer for Palm Beach Farms Co. In that capacity, he laid out the town of Lake Worth, built the light and water plant, started the first newspaper, opened the Bank of Lake Worth, of which he was president until 1923, and later became chief engineer of the Lake Worth Drainage District. He had maintained his own development corporation in West Palm Beach since 1922.

Harold Hansard Robertson (Affiliate '16) internationally known industrialist and chairman of the board of H. H. Robertson Co., died suddenly at a directors' meeting in his office in Pittsburgh, Pa., on September 19. He was 72. A native of St. John's, N.B., he came to the United States 36 years ago and founded his first company at Canton, Mass. Its major manufacturing plant is now at Ambridge, Pa. Mr. Robertson retired two years ago as president of the company but remained active in its affairs as chairman of the board. He belonged to the American Iron and Steel Institute, the American Society for Testing Materials, and the Engineers Society of Western Pennsylvania.

H. H. Robertson

George Edward Solnar, Jr. (Assoc. M. '44) since 1945 manager of the Clay Brick Manufacturers Association, San Francisco, Calif., died recently, at the age of 37. Receiving his engineering degree from Stanford University in 1938, Mr. Solnar entered the employ of the Pacific Railway, which he served successively as stress analyst, structural engineer, and project engineer. He then became assistant professor of civil engineering and field representative and director of the Stanford University Engineering, Science, and Management War Training Program. From 1942 to 1945 he acted as engineer in charge of studies in analytic mechanics with the Joshua Handy Iron Works for the U. S. Navy.

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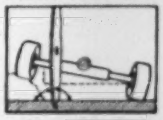

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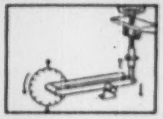
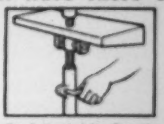


2. Positive Screw Feed Instant control raises or lowers blade smooth, easy.



3. Adjustable Depth Lock Set this handy stop for whatever depth desired.

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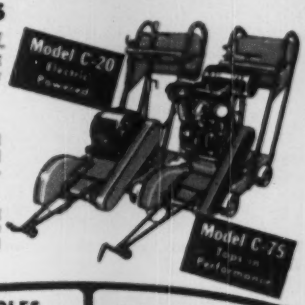
Clipper Concrete Saws ***CUT*** through the toughest concrete, wherever patches, trenches, openings or contraction joints are needed.



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NEWS OF Engineers

Clinton B. F. Brill, architect with the firm of R. B. O'Connor & W. H. Kilham, Jr., of New York, has been appointed special consultant to represent the Chicago engineering firm of DeLeuw, Cather & Co., in the New England area. Mr. Brill will also handle the Central and South American interests of the concern. His office is at 101 Park Avenue, New York.

Ridgway M. Gillis, formerly assistant state highway engineer for the California Division of Highways, Sacramento, has been appointed acting deputy state highway engineer, succeeding **Fred J. Grumm,** who recently retired (October CIVIL ENGINEERING).

Merger of the firms of Edwards & Kelcey and Lawrence T. Beck & Associates, New York consulting engineers, into a new partnership of **Dean G. Edwards, Guy Kelcey,** and **Lawrence T. Beck,** under the firm name of Edwards, Kelcey & Beck, is announced.

William J. Farrisee, dean of men at Clarkson College since 1946, has been named to the newly-created position of dean of the college. Dean Farrisee first went to Clarkson as an instructor in civil engineering in 1922. He is a graduate of Massachusetts Institute of Technology and has been on the faculties of Illinois, Yale, and Syracuse universities.

Donald B. Slawson, formerly assistant head of the Flood Control Section of the Portland, Ore., District of the Corps of Engineers, has been transferred to the Alaska District of the Corps as head of the Highway and Airfields Section.

Lee H. Johnson, Jr., dean of engineering at Tulane University, is conducting a survey of engineering education in Texas for the State Legislative Council, as part of a general review of higher education being undertaken by the state government.

David Auld has been named deputy director of sanitary engineering of the District of Columbia Water District, with headquarters in Washington. He succeeds **Ellwood Johnson,** who has retired.

Thomas M. Lowe, for the past eleven years head professor of civil engineering at Alabama Polytechnic Institute, has resigned to become director of the school of hydraulic engineering and head of the department of hydraulic engineering at Louisiana State University.

L. Vaughn Downs is now acting supervising engineer of the Irrigation Division of the Bureau of Reclamation's Columbia Basin Project, at Ephrata, Wash. He replaces **H. A. Parker,** who has been appointed acting district manager to fill the vacancy caused by the retirement of **Frank A. Banks** (October CIVIL ENGINEERING).

John McGhee, who has been with the Montana State Highway Department since 1925, has been named city engineer of Billings, Mont.

Lewis M. Young has opened a consulting office in Norwich, Conn. In engineering practice for 41 years, Mr. Young has been connected with several large firms, for which he has directed the design of many Norwich buildings and other structures.

George G. Edwards, after almost 30 years with the State Highway Planning Survey of the Texas Highway Department, Austin, has become connected with the Uvalde Rock Asphalt Co., Uvalde, Tex.

Lorenz G. Straub, director of the St. Anthony Falls Hydraulic Laboratory and head of the civil engineering department at the University of Minnesota, is attending a series of international engineering conferences in Paris at the invitation of the United Natsons Educational, Scientific, and Cultural Organization (UNESCO). The purpose of the conferences is to establish a Union of International Engineering Organizations and to draft a constitution for such a federation.

J. E. McKee, associate professor of sanitary engineering at the California Institute of Technology, has gone to Germany, where he will make a survey of that country's water and sewage works. He will also serve as adviser to the Public Health and Welfare Branch of the Office of the High Commissioner for Germany. He is being sent under a program of cultural exchange of American specialists.

Elmer W. Becker has been appointed assistant superintendent of the Milwaukee (Wis.) Water Works. Since 1924 Mr. Becker has been employed in the water construction division, becoming head of design and construction of water-main extensions in 1948.

Oliver T. Reedy has retired as administrative assistant to the chief engineer of the Colorado State Highway Department, Denver, Colo., after 29 years of service.

Burton S. Grant has been elevated to the post of chief engineer of water works and deputy general manager of the Department of Water & Power for the City of Los Angeles, Calif. He succeeds **Laurance E. Goit,** who requested appointment to a

Burton S. Grant

Samuel B. Nelson

lower position because of his health. **Samuel B. Nelson,** formerly head of the Aqueduct Division of the department, has been named assistant chief engineer of water works.

Andrew G. Bisset, vice admiral, CEC, USN, retired July 1 after 33 years of active duty. In 1944 he became Navy Construction Officer and Senior Naval Construction Brigade Commander in connection with the planning and operations in the western Pacific and later was assigned to the Tenth Army and made Commander Construction Troops in the assault and base development at Okinawa. In this operation he had command of approximately 100,000 Seabees and Army engineer troops for the construction of 21 airfields and a major naval base. He graduated from Lafayette College with honors in 1915 and was commissioned in the Navy in 1917.

Admiral Bisset

Donald E. Stearns has resigned as chairman of the department of civil engineering in the College of Applied Science, Syracuse University, to conduct a private consulting practice in water supply and sewerage in the central New York area. Professor Stearns went to Syracuse University in July 1945 after a four-year association with the Boston consulting firm of Fay, Spofford & Thorndike. **Charles Antoni,** secretary of the Syracuse Section of the Society, is now acting head of the civil engineering department.

Carl H. Reeves, sewer maintenance superintendent for the County of Los Angeles, Los Angeles, Calif., retired in October after 26 years of service. Colonel Reeves has completed 50 years of engineering and is a Life Member of ASCE.

Lloyd K. Clark has joined the consulting firm of Clark & Groff Engineers, Salem, Ore., as sanitary engineer. Mr. Clark recently completed a four-year sanitation research and development project for the Association of American Railroads, at Baltimore, Md.

John L. Savage, Denver, Colo., consultant and ASCE Honorary Member, has been awarded the Department of the Interior's gold medal for distinguished service. As chief design engineer for the Bureau of Reclamation before his retirement in 1945, Mr. Savage designed many of the country's great dam projects.

Eugene P. Hapgood, city engineer of Anaheim, Calif., has retired after 26 years of service. During his tenure as city engineer, Mr. Hapgood directed construction of many buildings, streets, and the Joint Outfall Sewer. He was instrumental in the formation of the Metropolitan Water District, which he later served as a director.

The newly formed Intermountain Institute of Consulting Engineers, with headquarters in Salt Lake City, Utah, elected the following officers at a recent organizational meeting: **LeRoi C. Chadwick,** president; **Win Templeton** and **Amos Jackson,** vice-presidents; **George W. Poulsen, Jr.,** secretary; and **S. D. Caplan,** treasurer. The purpose of the organization is to bring together all consulting engineers in the area regardless of their branch of the profession.

(*Continued on page 76*)

LINK-BELT

Belt Conveyors Feed Aggregate to HUNGRY HORSE

Conveyor System at Montana Dam Project

Link-Belt roller bearing belt conveyor, 30" wide x 850' long, feeds tripper and wing conveyor for stock-piling raw materials at Hungry Horse.

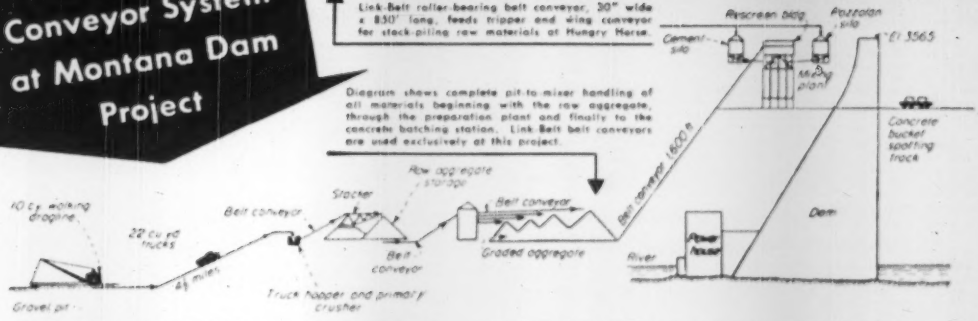
Diagram shows complete pit-to-mixer handling of all materials beginning with the raw aggregate, through the preparation plant and finally to the concrete batching station. Link-Belt belt conveyors are used exclusively at this project.
Pozzolan silo
Cement silo
Mixing plant
El. 3565
Concrete bucket hoisting tower
Raw aggregate storage
Stacker
Belt conveyor
Belt conveyor 1600' ft
Graded aggregate
Dam
Power house
River
10 cu. yd. mixing dragline
22 cu. yd. trucks
4½ miles
Gravel pit
Truck hopper and primary crusher

Pick Montana as the site for the world's fourth largest dam and you get a job calling for action aplenty in the limited work season; a job demanding efficiency and durability in conveyor equipment.

Link-Belt conveyor idlers, terminal machinery and drives for belt conveyors are "feeding" Hungry Horse; helping to move aggregate from gravel pit to mixer with a goal of 1,000,000 cubic yards of concrete scheduled for the work season of 1950.

Leeway for costly shutdowns and excess time for maintenance are out. That's why here—as in many other construction jobs—you see Link-Belt conveyors at work.

Link-Belt experience pays off in tonnage delivered and in low-haulage costs. Consult our nearest office.

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LINK-BELT

BELT CONVEYOR EQUIPMENT

ROLLERS • TROUGHING • BELTS • PULLEYS

SPROCKETS • DRIVES

(Continued from page 74)

Three ASCE members are among University of Minnesota alumni honored at a recent dinner with "outstanding achievement medals." They are: **George M. Shepard,** chief engineer of the St. Paul Department of Public Works; **Franklin R. McMillan,** of Asheville, N.C., former director of research for the Portland Cement Association; and **Leif Sverdrup,** St. Louis consulting engineer.

Walter L. Willig, professor and chairman of the department of civil engineering at the College of the City of New York, has been appointed assistant dean of the college's School of Technology, in charge of graduate studies. Professor Willig will retain his present post as civil engineering chairman.

Loren R. Heiple has been appointed professor and head of the department of civil engineering at the University of Arkansas, succeeding **Prof. W. R. Spencer,** who will devote his time to research in materials of construction in the department.

Harold E. Nelson has assumed new duties as executive officer of the Pittsburgh District of the Corps of Engineers. He will serve as assistant to the district engineer in work involving flood control and investigation projects and in the construction of two VA hospital projects in Pittsburgh. Prior to his new assignment, Colonel Nelson served for three years as an instructor in the Tactical Department of the Infantry School.

Edward G. Herb, who has been on construction duty in Okinawa for the Corps of Engineers, will assume new duties as district engineer, at Tulsa, Okla., early in December. He succeeds **Edward G. Daly,** who has been transferred to Fort Campbell, Ky.

Harold D. Rouse, since 1944 with E. I. du pont de Nemours & Co., Wilmington, Del., has reported at Martinsville, Va., as field project manager in charge of building a large addition to the organization's nylon yarn plant there.

Andrew Brodsky, until recently on the civil engineering faculty of the College of the City of New York, is now working as a structural and production engineer for the Porete Manufacturing Co., North Arlington, N.J., manufacturers of precast concrete products. His work will include the development and manufacture of prestressed concrete slabs.

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ASSISTANT PROFESSOR OR INSTRUCTOR. Jun. M. ASCE; M.S. in C.E. and doctor of science in applied mechanics; 2½ years' experience as structural designer, 3 years as instructor, 1 as research fellow. Desires teaching position in engineering college or university. C-630.

STRUCTURAL ENGINEER. Assoc. M. ASCE, P.E., New York. C.E. Cornell University; 14 years on structural design and construction of hospitals, mill buildings, locks and dams; 4 years in Latin America; knowledge of Spanish and understanding of Latin Americans; desires position abroad in structural design and construction offering opportunity to develop country. C-631.

CIVIL ENGINEER. Jun. M. ASCE; B.E., S.M. (structural), M.I.T.; 4 years' experience covering maintenance and office administration for railway company and design and construction for an aluminum company; summers in steel erection and highway work. C-632.

Positions Available

CONSTRUCTION SUPERINTENDENT, 40-50, with about 10 years' supervisory experience on institutional buildings. Will take charge of hospital project. Salary, $7,800 a year. Location, upstate New York. Y-4190 rewr.

SENIOR DESIGN ENGINEER, 35-50, civil graduate, with general structural design experience, to design new structures and modifications of existing structures for utility company. Salary, $5,000-$6,000 a year. Location, Pennsylvania. Y-4196 (5).

CIVIL ENGINEER, 30-40, with construction experience covering highway, railroad, drainage etc., for sugar mill plantation. Previous experience in Central America desirable. Salary, $5,000-$6,000 a year. Location, Caribbean area. Y-4212.

STRUCTURAL ENGINEER for reinforced concrete design. Must have had 5 to 10 years' experience in flat slab design, preferably New York regulations. Salary, $5,200-$5,720 a year. Location, New York, N.Y. Y-4219.

ESTIMATOR, 30-40, graduate preferred, with experience in material take-off and pricing. Construction experience advantageous. Will prepare construction cost estimates of chemical plants from equipment lists, drawings, specifications, and flow diagrams. Location, Delaware. Y-4221.

DRAFTSMEN AND DRAFTSWOMEN with 2 to 10 years' experience in road and bridge engineering work. Salary open. Location, New York, N.Y. Y-4231.

ENGINEERS. (a) Architectural and structural designers, with 1 to 3 years' experience in industrial building, mostly of warehouse type. Will also consider applicants over 50, who have had considerably more experience. Salary, $4,200-$6,000 a year. Location, Pittsburgh, Pa. Y-4243(a).

SANITARY ENGINEERS for state department of health. Degree in sanitary engineering and 6 years' sanitary engineering experience, two of which have been in a supervisory capacity. Salary, $4,800-$6,000 a year, with generous vacation and sick leave, automatic salary increases, and retirement benefits. Location, East. Y-4234.

ENGINEERS. (a) Sanitary Engineer, recent graduate in civil engineering with a major in sanitary engineering. Must be interested in plant operations, initially to actually operate sewage plant equipment. Salary $2,320 a year with increase after 6 weeks and another after 6 months, plus shift bonus and overtime. (b) Industrial Waste Engineer, civil, with a major in sanitation. Must have 2 to 5 years' experience in sewer plant operation, control, and other special problems relating to industrial wastes. Salary, $3,600-$3,900 a year. (c) Graduate Civil Engineer with major in hydraulics for water department. Must have 2 to 5 years' experience in the design and operation of industrial water plants and distribution systems. Duties to design water-distribution systems, to have a working knowledge of deep rock wells, and to be familiar with operation of water-cooling towers and with pump operations, selection, and maintenance. Salary, $3,600-$3,900 a year. Location, New York metropolitan area. Y-4255.

ENGINEERS. (a) Construction Superintendent of buildings. Must have previous experience in housing, particularly involving precast concrete slabs. Salary, $8,400 a year. (b) Concrete Carpenter Superintendent with a minimum of 5 to 10 years' experience in heavy industrial buildings. All steel forms used. Salary, $9,600 a year. (c) Estimator-draftsman for general industrial building layout and quantity take-off. Salary, $5,600 a year. Location, South America. Y-4270.

RESEARCH DIRECTOR, 30-40, with at least a B.S. in civil engineering or engineering mechanics, will consider a degree in ceramic engineering. Will direct a program of research concerned with the use of structural clay materials in the building industry, with emphasis on the building methods and products of the Southeast. A minimum of 5 years' experience, combining contact in construction, materials testing, design, and architectural work. Must have capacity to appreciate structural requirements and visualize potential uses of structural clay products to meet them. Some travel to various structural clay plants in the Southeast. Salary, $6,000-$8,000 a year. Location, Southeast. Y-4278.

FIELD ENGINEERS, graduate, civil, single status, for general engineering work including some layout and design, construction of small houses, some surveying, road and sewer work. About 3 years' experience in the field required. Salary, about $6,000 a year. Location, South America. Y-4280.

BUILDING CONSTRUCTION SUPERVISORS (2) with a minimum of 5 years' experience in over-all supervision of large housing or residential projects. Will act as general superintendent. Salary, $6,500-$7,500 a year. Location, New York, N.Y. Y-4283.

CHIEF ENGINEER with 10 to 15 years' experience in highway construction, for assignment in Far East. Salary, $10,800 a year plus living allowance. Y-4312.

SPECIFICATION WRITER, some experience in the preparation of brief, clear, and concise construction specifications for dams, hydroelectric plants, and other heavy construction for an engineering consultant. Salary, to $600 a month. Location, Illinois. R-6939.

CHIEF ENGINEER, 30-50, with experience in heavy construction and building contracting, familiar with estimating, bidding, negotiating, operation, etc. Permanent. Salary open. Location, Northwest. S-416.

This placement service is available to members of the Four Founder Societies. If placed as a result of these listings, the applicant agrees to pay a fee at rates listed by the service. These rates—established to maintain an efficient nonprofit personnel service—are available upon request. The same rule for payment of fees applies to registrants who advertise in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York Office. Please enclose six cents in postage to cover cost of mailing and return of application. A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription rate of $3.50 per quarter or $12 per annum, payable in advance.

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Recent BOOKS

International Association for Bridge and Structural Engineering

The 25 papers comprising Volume 9, 1949, of the publications of the International Association for Bridge and Structural Engineering deal with various aspects of the theory and practice of structural engineering: deflection analysis; bridge testing and reconstruction; stress analysis; timber connections; use of stabilized soil; and analyses of frameworks or particular structures. Thirteen of the papers are in English, nine in French and three in German, with the titles and summaries in all three languages. There are 404 pages and illustrations. (Published by the German Secretary in Zurich, Switzerland, and for sale in New York at Stechert-Hafner at $12.15.)

Materials of Construction

A knowledge of fundamental principles of statics and mechanics of materials and of general chemistry is assumed by J. H. Bateman in this textbook for undergraduate civil and architectural engineering students, which considers the raw materials, production processes, and properties of the principal materials of construction. More than half the book is devoted to mineral aggregates, concrete, wood and ceramic materials and the remainder to the metals. (Pitman Publishing Corp., New York, Toronto, London, 1950, 568 pages, illustrations, $6.50.)

Symposium on Accelerated Durability Testing of Bituminous Materials

Accumulated data on the standardization of durability and accelerated service tests representing resistance to normal weathering presented at the 52nd annual meeting of the ASTM, Atlantic City, N.J., June 30 and July 1, 1949, are now available in Special Technical Publication No. 94. Topics considered include the highway and roofing purposes of all bituminous materials, the effect of ultraviolet light, water, radiation, mineral stabilizers, oxidation and evaporation, the use of an abrasion test, immersion-compression comparison with traffic tests, and the design and application of a spark-gap instrument. (The American Society for Testing Materials, 1916 Race Street, Philadelphia, Pa., 1950, 181 pages, illustrations, $2.)

Theory of Modern Steel Structures

Major changes have been made in the abridged version of L. E. Grinter's two-volume text for nonstructural engineering students, by reducing the chapters on statically indeterminate structures, space frames, and tier buildings. Analysis of simple roof and bridge trusses, plate girders, portal frames, and diagonally braced frameworks are still included. Considerable attention is given to loadings, structural arrangement and construction details. Published by Macmillan Company, New York, 1950, the book contains 421 pages and illustrations and sells for $6.60.

Theory of Flow and Fracture of Solids, Vol. I

The first volume of a revision of A. Nadai's earlier work, *Plasticity*, emphasizes the mathematical principles and mechanical laws governing flow and fracture. Discussion of the details and results of research on the yielding and fracture of ductile metals under combined stress, and a survey of the general conditions causing fracture in materials broaden the scope of the edition. The illustrated, 572-page book is priced at $10 and published by McGraw-Hill Book Co., New York, Toronto, London, 1950.

New Publications

Geology in Engineering. Early issuance of an important volume, *Application of Geology to Engineering Practice*, is announced by the Geological Society of America. Edited by Sidney Paige, the volume will consist of twelve chapters covering different engineering applications of the science of geology, by experts in the various fields represented. The volume is dedicated to ASCE Honorary Member Charles P. Berkey, noted geologist, for his part "in integrating geology and engineering practice." Inquiries concerning the book, which will be priced between $3 and $4, should be addressed to H. R. Aldrich, Secretary of GSA, 419 West 117th Street, New York 27, N.Y.

Off-Street Parking. Bulletin No. 24 of the Highway Research Board consists of an analysis in two parts of the requirements for provision of parking facilities in connection with various property uses, as contained in 155 local ordinances. Discussion of various subjects connected with provisions of the required parking facilities comprises Part I of the bulletin. Also included is a model for a section in a zoning or other local ordinance requiring provision of parking facilities. Part II is made up of a basic table containing ordinance data for each of the 155 local units. The two parts sell for $3, upon application to the Highway Research Board, Washington 25, D.C.

Plasticity. An addition to the Engineering Societies Monographs series is announced by the Engineering Societies Library with publication of *Theory of Flow and Fracture of Solids by A. Nadai*. The monograph is the first of a two-volume revision and expansion of Dr. Nadai's pioneer work, *Plasticity*, which constituted the first volume in the Engineering Societies Monographs Series when it was initiated in 1931. Inquiries about the publication, which sells for $10, should be addressed to the Library, 29 West 39th Street, New York 18, N.Y. The monograph series is made available by a special arrangement of the Founder Societies with the McGraw-Hill Co. "for the production of selected books adjudged to possess usefulness to engineers or industry, but not likely to be published commercially."

City Planning. The program of public improvements recommended by the Philadelphia City Planning Commission for the years 1950 to 1955 is set forth in a recent illustrated release of the Commission. For the six-year period, the Commission has scheduled improvements estimated at $537,298,200, an amount considerably in excess of the $257,305,800 total of the 1949–1954 program. The present program includes expenditures for highway, housing, and redevelopment projects for which state and federal funds are available. Inquiries should be addressed to the Philadelphia City Planning Commission, Market Street National Bank Building, Philadelphia 7, Pa.

(Continued on page 80)

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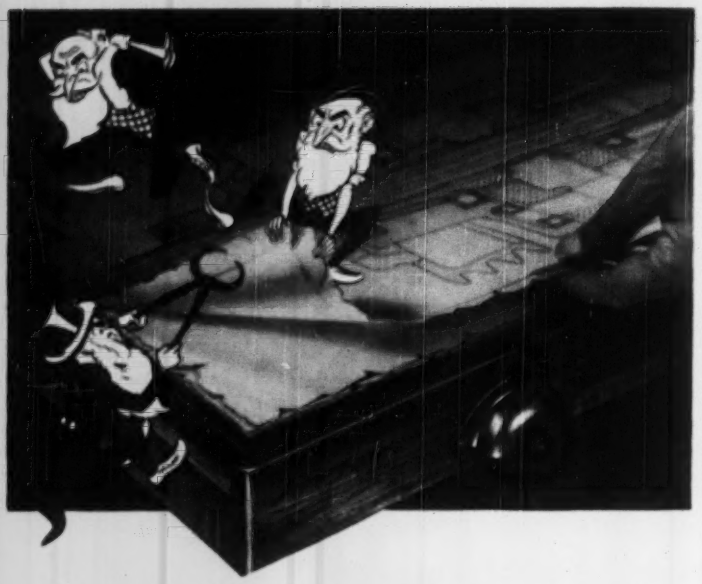

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(*Continued from page 79*)

Concrete Progress. To make more useful the hundreds of papers published since 1929 in the ACI *Journal* and ACI special publications, the American Concrete Institute has published the *ACI 20-Year Index*. The book is divided into three main sections—index of subjects, authors, and titles; sources of equipment, materials, and services; and synopses of papers and reports, items on job problems and practices, and letters from readers. Copies may be obtained from the ACI, 18263 West McNichols Road, Detroit 19, Mich., at $2 each ($1.25 for ACI members).

Building Materials. A 72-page technical bulletin of new and improved building products for residential construction has been compiled for the benefit of architects and engineers by the Producers' Council. Copies of the bulletin, designated No. 57, are obtainable from the Producers' Council, 815 Fifteenth Street, Washington 5, D.C.

Hydraulic Research. The results of tests made for Hirakud Dam at the Colorado Agricultural Experiment Station are discussed in a recent report of the Civil Engineering Section. A description of the construction and testing of the models is included. The report was prepared for the International Engineering Co., consultants to the government of India on the design of the structure. A limited supply of the report is available from the Civil Engineering Section, Colorado A & M College, Fort Collins, Colo., at $3.50 a copy.

Traffic Engineering. A revised and expanded edition of the *Traffic Engineering Handbook* is being published jointly by the Institute of Traffic Engineers and the Association of Casualty and Surety Companies. A source book of techniques, principles, and standards in the field, the publication is intended as a practical guide to traffic engineers and others called upon to solve traffic problems. Copies, priced at $6 each or $5 in lots of more than 25, may be obtained from the Accident Prevention Department, Association of Casualty and Surety Companies, 60 John Street, New York 7, N.Y.

Construction Costs. Persons planning to erect new buildings or remodel old ones will find pertinent information in a recent booklet of the Associated General Contractors *Undivided Responsibility—Key to Lower Costs*, which presents contractors' reasons for preferring a single over-all contract. Copies of the 16-page, two-color brochure may be obtained through the AGC headquarters in the Munsey Building, Washington 4, D.C.

Beach Erosion. Two publications of the Beach Erosion Board outline recent East and West Coast investigations. Tests of the feasibility of nourishing eroded shores with dredge spoil, made by the Board and the New York District of the Corps at Long Branch, N.J., are set forth in Technical Memorandum No. 17. The accretion of beach sand behind a detached breakwater at Santa Monica, Calif., is recorded in Technical Memorandum No. 16. Inquiries should be addressed to the Beach Erosion Board, Department of the Army, Washington, D.C.

Columbia Basin Project. Issuance of a new engineering monograph on *Soap Lake Siphon* by Robert Sailer, Assoc. M. ASCE, is announced by the Bureau of Reclamation. Designed by Mr. Sailer, the siphon is an important irrigation feature of the Columbia Basin Project. It contains an 8,250-ft-long steel-liner in the 22-ft 4-in. diameter, high-head section of the concrete pipe, an innovation in Bureau engineering practice. Fifth in a series of recent Bureau monographs, the present publication (No. 5) may be obtained from the Bureau of Reclamation, Denver, Colo., or Washington, D.C., at 25 cents a copy.

Wellpoint System. *The Wellpoint System in Principle & Practice* describes how the wellpoint system functions, methods of planning, its layout, installation, operation, and removal. The price is $1.50 a copy. Contractors and engineers may obtain complimentary copies from the Griffin Wellpoint Corp., 881 East 141st Street, New York 54, N.Y.

Traffic Control. Extensive factual data bearing on highway safety and related factors are contained in a report, *Highway Safety—Motor Truck Regulation*, prepared by the Council of State Governments at the direction of the Governors' Conference. The book deals specifically with driver licensing, traffic control regulations, law enforcement, highway engineering, regulation of motor truck sizes and weights, and motor vehicle taxation. Copies may be purchased from the Council of State Governments, 1313 East 60th Street, Chicago 37, Ill., at $1 each.

River Flow. In a paper-bound volume entitled *Daily River Stages—1947*, the Department of Commerce and the Weather Bureau have made available the forty-third of a series of Daily River Stages on the Principal Rivers of the United States, which was begun by the Signal Service of the Army and has been continued by the Weather Bureau. Volumes XXXIII to XLIII (the current report) can be bought from the Superintendent of Documents, Washington, D.C., at 75 cents. Earlier volumes are out of print.

Concrete Testing. Studies of the resistance of concrete to natural weathering, made at experimental exposure stations in Maine and Florida, are reported by the Waterways Experiment Station in Supplement No. 1 to Technical Memorandum No. 6-226, entitled *Durability of Concrete Exposed to Natural Weathering*. Copies sell for $1 each, upon application to the Waterways Experiment Station, Vicksburg, Miss.

ASCE MEMBERSHIP AS OF OCTOBER 9, 1950

Members	7,728
Associate Members	9,909
Junior Members	12,563
Affiliates	68
Honorary Members	39
Fellows	1
Total	30,108
(October 9, 1949	26,825)

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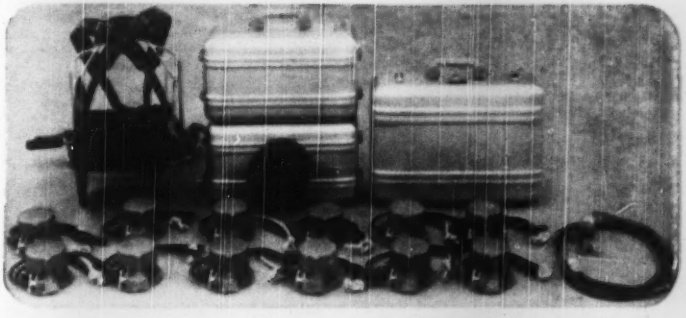

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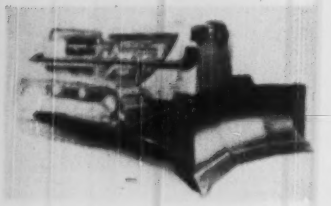
A LARGE CAPACITY, U-shaped bulldozer was designed for universal use in a variety of earth-moving applications with the Caterpillar diesel D8 track-type tractor. The design permits long haul pushing of loose material with minimum end spillage when bulldozing straight ahead. It is an excellent tool for stockpiling, handling large capacity loads and allowing good maneuverability. The U-shaped bulldozer



Available with Interchangeable Front-End Attachments

does smooth finishing, quick back-filling, and pioneering and side hill work. In addition, its U-shaped blade makes it a convenient tool for felling trees. The complete unit is cable-controlled and consists of blade, push arms, trunnions, cables, sheaves, and sheave brackets. The No. 8U bulldozer has a box-type moldboard construction, 1-in. steel cutting edge, and heat-treated carbon steel end bits. **Caterpillar Tractor Co., Peoria 8, Ill.**

Condenser Chronograph

A COMPLETE APPARATUS for the dynamic method of measuring propagation velocity of longitudinal sound waves in elastic solids comprises: a condenser chronograph, type W-15, a pair of pilzo-electric pick-ups, U-shaped iron bar, by means of which the pick-ups can easily be spaced 10, 20, 30, etc. centimeters, and an electrically operated hammer to develop the waves. The modulus of elasticity of solids can be calculated by measuring the velocity of sound waves in the material when the specific gravity and in special cases Poisson's ratio for the material is known. It is very important that mechanical connections to other materials have no influence on the measuring. It is consequently possible to measure floors or pillars in finished buildings and determine the modulus of elasticity from the velocities measured. A further, great advantage is the fact that the method is non-destructive, so it is possible to examine the changes due to factors as temperature, moisture, etc. **M. P. Weibel, Copenhagen, Denmark.**

Concrete Saws

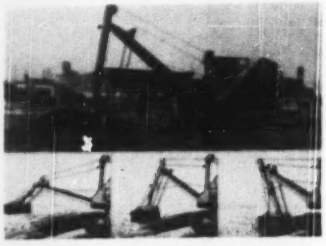
THREE NEW PORTABLE concrete saws have been announced. Concrete floors, streets, airport runways, or asphalt can now be sawed quickly and easily to provide straight, smooth edges before breaking. Users have proven that concrete sawing is completely practical and economical on the smallest patch job as well as on production sawing of contraction joints on streets and highways. The cutting speed is 12 ft per min in asphalt, and up to 5 ft per min—1 in. deep—in limestone concrete. The maximum depth of cut is 6½ in. Concrete contractors, utility companies, street repair departments, as well as paving contractors and highway maintenance divisions will find the two gasoline powered clippers, the Model C-75 with 7½ h.p. engine, or the power packed C-130 with a 13 h.p. 2-cylinder engine, best designed for their needs. Each is counter balanced to "turn on a dime." Models C-15 and C-20 with electric motors are produced specifically for plumbers, electrical contractors, and building maintenance departments.

Practical and Economical

The Model CHD makes it possible for present owners of Clipper Model HD's to convert their masonry saws for concrete sawing. Outstanding features claimed are: floating three point suspension which eliminates blade binding as saw is moved over rough surface, positive screw feed, streamlined design for ease of handling. Many uses are described in illustrated literature #1 now available, such as patching, sawing utility trenches, opening for setting new light poles, scoring designs, cutting contraction joints. A complete selection of Metal Bonded Diamond blades suitable for sawing concrete with limestone, flint or granite aggregate are also available. **Clipper Manufacturing Co., Concrete Saw Div., Dept. C, 2800 Warwick, Kansas City 8, Mo.**

Backfill Blade

A REVOLUTIONARY BACKFILL blade attachment, which greatly speeds covering and leveling of all types of excavation and trenching work, has just been announced. Designed for fast, interchangeable operation with the ¾ yd truck-mounted Schield Bantam trench hoe, the backfiller consists of a cable-operated steel blade mounted on a wishbone dip stick, with two tubular control arms, which

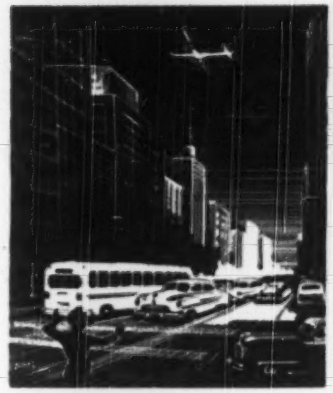


Designed for Use with the D-8 Track-Type Tractor

hold the blade vertical to the ground as it is pulled toward the machine. Equipped with heavy-duty 24" × 60" blade with ½" reversible cutting edge, the attachment is reported to have a maximum reach of 23 ft 6 in. in any direction, plus ability to work to within 6 ft 6 in. of the center of machine rotation. It can also be controlled vertically to within 1 in. of the ground surface, thus permitting smooth finished backfill in level city parkways, cemeteries, etc., without damage to underlying grass. Ability of the truck-mounted Bantam to travel at will over paved roads or cross-country at speeds up to 35 m.p.h. enables the trenching-backfilling tool to offer substantial economies. The Bantam is also available with interchangeable front end attachments for handling a wide variety of shovel crane, dragline, clamshell and pile driver work. **Schield Bantam Co., Waverly, Iowa.**

Concrete Finishing Material

A CONCRETE FINISHING MATERIAL called "Speed Finish" is now offered. This material is used in place of the usual rubbing method of finishing concrete. It eliminates the objectionable and costly features of the rubbing method and does not destroy any properties of the concrete. Instead, Speed Finish develops a mechanical and chemical bond with the original concrete, greatly improving the appearance and durability of the surface and acting as a barrier against the elements, abrasion, and spalling. Write for further information to **Irvington Form & Tank Corp., Dept. CV-F, 20 Vesey St., New York 7, N. Y.**



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Equipment, Materials & Methods (Continued)

Acid and Alkali-Proof Cement

AN ENTIRELY NEW and different type of thermo-setting resin used as an acid and alkali-proof cement or coating, called Duron, is announced. It is remarkable in that it will adhere without the use of a primer to concrete or metal, and is self-hardening at room temperature. The novel adhesive properties are due to the fact that, unlike thermo-setting cements and coatings heretofore produced, Duron is not derived from phenolic or furfuryl alcohol resins. It is used in the manufacture of acid and alkali-proof cements for joining brick and tile, as a coating for concrete, steel, or wood and as an impregnant for wood. Useful materials may be produced by mixtures with metal powders, asbestos, cork and other insulating materials. Duron is inert to solvents, fats, oils, greases, alkalis of all concentrations, and to a wide range of acids. **The Electro Chemical Supply & Engineering Co., 750 Broad Street, Emmaus, Pa.**

Backhoe

CONSTRUCTION OF FRANK ROAD Trunk Sanitary Sewer just outside the corporation limits of Columbus, Ohio, moves forward on a speedy pace with the aid of the Marion Type 362, 1½ cu yd backhoe shown in this picture. The 362 backhoe was delivered to the construction company about the same time the sewer project got under way last April 26. When

Type 362

the accompanying photo was taken about June 1, the machine had dug approximately ½ mile, leaving some 1,000 ft of excavation to go. The Marion is digging for a 42 in. line that will be 3,500 ft long when finished. It is expected that the entire sewer will be completed early in the fall. **Marion Power Shovel Co., Marion, Ohio**

Civil Engineers' Machine

THE HIGHLY SPECIALIZED machine is designed for extreme accuracy in making maps. The Protractor is divided to ½ degree; a double vernier reads to 1 minute; two rows of figures—one by quadrants, one from 0 to 360 degrees. A micrometer screw and a magnifying glass make possible extremely accurate angle settings. This machine repeats on the drafting board the operation of a transit in the field, the edge of the scale taking the place of the line of collimation of the telescope. This enables the engineer to plot any type of surveying data directly from field notes. **V. & E. Mfg. Co., Pasadena, Calif.**

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ENGINEERING HYDRAULICS

Proceedings of the fourth Hydraulics Conference, Iowa Institute of Hydraulic Research

Edited by HUNTER ROUSE
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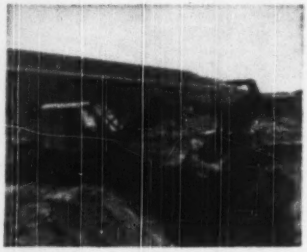
Trench Hoe

A GOODENECK BOOM hoe attachment for the P&H Model 255A excavator is announced. This attachment incorporates many new features in trench hoe design which make possible higher speeds, greater digging depth, maximum ruggedness and better over-all performance. Operation of the trench hoe is 50% faster due to only a two-part hoist line. It has a



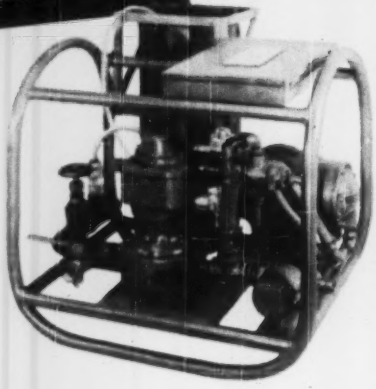
Model 255A

power operated auxiliary gantry for raising and lowering the boom. The new design permits greater digging reach and digging depth and greater dumping height, which means fewer moves and more yardage. Also, a greater amount of power is made available for the toughest digging by P&H's low gear transmission. The machine can cut vertical end at start of the trench and also can trim vertical walls. There is a chopping action due to the special hoe stick linkage. Information may be obtained by writing the **Harnischfeger Corp., Small Excavator Division, Milwaukee 14, Wis.**

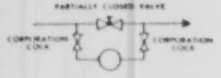
Sewer Pipes Coated

A MASTIC INSULATION to prevent both condensation and corrosion, was used recently to spray over 22 miles of pipe at the Chicago Sanitary District. This product is a Gilsonite base coating which is widely accepted by industry because of its ability to insulate and prevent corrosion in one application. It is applied by spray gun to a thickness of 1/4 in. to 3/4 in. Insul-Mastic Type "D" contains a large amount of granulated cork which gives it excellent insulating and condensation preventing characteristics. The insulation adheres directly to the pipes and needs no other form of attachment. It will cling at any angle. This firm adhesion also prevents formation of moisture under the insulation. Type "D" has a K Factor of approximately .36 per sq ft per in. thickness. This remains constant for the life of the coating. It is water resistant and, therefore, needs no additional waterproofing as would be the case with standard insulations. The corrosion preventing factor of the coating is provided by the mastic binder, which in itself is a protective coating widely used by industry to resist the corrosive effects of chemicals and weather, and is also used to seal building walls against moisture. **Insul-Mastic Corp. of America, 1141 Oliver Bldg., Pittsburgh 22, Pa.**

ANNOUNCING!
A New PORTABLE Unit
FOR FLOW-PROPORTIONAL CHLORINATION AND MAIN STERILIZATION



● for use in by-pass around closed gate valve to chlorinate heavily for main sterilization.



● for use in by-pass around partially closed gate valve acting as a variable orifice to maintain a light disinfecting residual while main is in use.

%Proportioneers% new portable main sterilization unit is ready for work, any time, any place. Designed for emergency or general chlorination, this unit is light and compact — it can be easily carried wherever needed. It's a rugged, self-contained "package" — complete in every detail — including Chem-O-Feeder, Treet-O-Control meter, and chlorine solution tank with inter-connecting piping.

You don't need electricity or other outside power for this unit — it operates hydraulically, driven by the main line pressure. Chemical feeding is automatically maintained in exact proportion to the flow through the main, with feeding rates adjustable up to 5 gals. per hr. at pressures from 15 to 100 p.s.i.

Municipalities, contractors and consulting engineers have put the stamp of approval on this new water treating unit. For complete information, write %Proportioneers, Inc.% 360 Harris Ave., Providence 1, Rhode Island.

Ask for BULLETIN SM9365 AND YOUR WATER MAIN STERILIZATION CHART

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Lithographed on stone by James E. Allen

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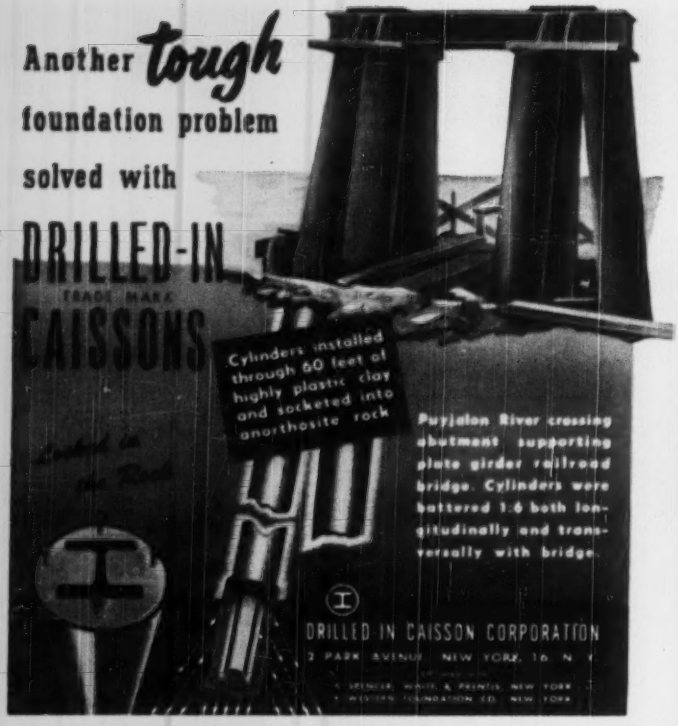
Cylinders installed through 60 feet of highly plastic clay and socketed into anorthosite rock
Purjalon River crossing abutment supporting plate girder railroad bridge. Cylinders were battered 1:6 both longitudinally and transversally with bridge.
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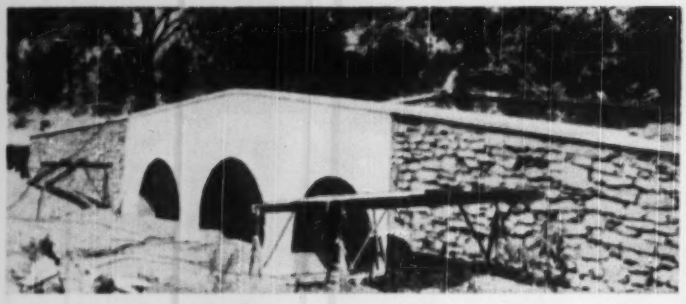


"GUNITE" MAKES OLD STONE BRIDGE SAFE

This small arched bridge belonging to the Pennsylvania State Highway Department was rebuilt to safe strength for normal traffic with "GUNITE". Loose mortar was cleaned from all joints and "GUNITE" was applied to repoint the masonry, line the arch barrel and reinforce the end walls. After this photo was taken the stone masonry approach walls were also repointed and "GUNITED".

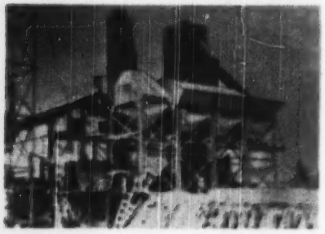
This and many other practical repairs to existing structures have been made with "GUNITE" and are illustrated and described in our new Bulletin B2400. A request on your letterhead will bring you your copy.

CEMENT GUN COMPANY
"GUNITE" CONTRACTORS
GENERAL OFFICES—ALLENTOWN, PENNA. U.S.A.
MANUFACTURERS OF THE CEMENT GUN

Equipment, Materials & Methods (Continued)

Unit Batch Plant

A SOLUTION TO AGGREGATE and bulk cement storage and batching has been reached, with the announcement of a new unit batch plant incorporating numerous combinations and applications. The units, built in a capacity to handle the charging of one yard mixers or smaller, come in single or dual aggregate units which may be hooked up in series with a bulk cement bin unit and with an auxiliary cement silo if additional storage is required. Upon the completion of a particular job the units may be rearranged to meet other conditions. A weigh hopper, mounted on a double rail track, travels from bin to bin without interruption and may be set to dump from either side or either end. The unit batch plant features bin frames mounted on skids or demountable wheels for easier transporting. An added feature is self-closing bin gates. The versatility of the plant materially reduces aggregate and cement storage costs and reduces equipment inventory. **Gar-Bro Mfg. Co., 2416 E. 16th St., Los Angeles, Calif.**

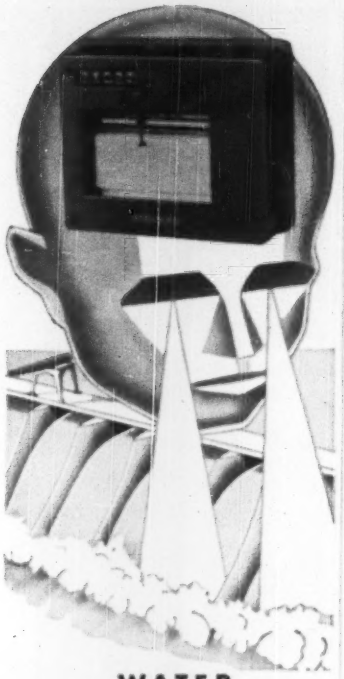


Versatility Reduces Costs

Bearing Brackets

THE RE DESIGN OF A STANDARD line of large, bracket-bearing, squirrel-cage induction motors of four and more poles to provide more protection and greater accessibility has been announced. Capsule-type sleeve bearings are standard. The split, cast-iron bearing capsule or housing has a machined flange for bolting to the bearing bracket. This permits removal of the upper half of the bracket for inspection or cleaning without exposing the inside of the bearing. Similarly, the ample air-discharge openings in the side of the stator yoke, protected by removable louvers, facilitate vacuum cleaning or blowing out the air passages behind the stator core. Since the only openings in the bearing brackets are in the air intakes near the bottom, the brackets afford effective protection for the ends of the motor. This construction, plus the use of louvered panels in the stator air-discharge openings, makes the standard design drip-proof. Splash-proof motors with internal baffling of air passages are also available. The large, stator air-discharge openings also facilitate installation by providing

(*Continued on page 87*)



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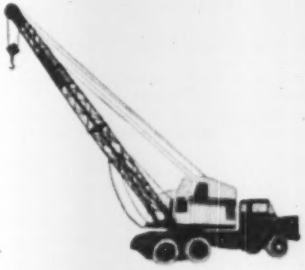
Equipment, Materials & Methods (Continued)

adequate headroom for drilling and doweling the machine to its foundation. In addition, the foundation bolts and doweling are out of sight behind the discharge louvers. Tapped, plug-protected holes in the brackets permit easy checking of the air gap. Ventilating air intake and discharge openings and internal passages in both the bearing brackets and the stator are liberally proportioned to provide uniform ventilation for freedom from hot spots and moderate air velocities for quiet operation. The motors are available with special electrical modifications to suit application requirements. They can be had with anti-friction bearings whenever the speed and application are suitable. **Allis-Chalmers, Milwaukee, Wis.**

Truck Crane

A 12½-TON TRUCK-MOUNTED crane-excavator, known as the Model 40, has been announced. The truck crane has an increased swing speed to 6.4 r.p.m. and travels at truck speeds—converts easily to all crane and shovel attachments. The heavy-duty carrier is engineered and built especially for crane service. Husky, wide-flanged, deep-section I-beam frames provide a solid crane base. Equalizing beam-type suspension and a locking third differential make possible



Model 40

heavy, off-the-road work. An auxiliary transmission provides ten forward and two reverse speeds. The Model 40 lifts, booms and swings either simultaneously or independently. Standard power unit is a six-cylinder gasoline engine which develops 105 h.p. at 3200 r.p.m. Other gasoline and diesel engines are available. The upper works of the machine are enclosed in a weatherproof, inside-bolted cab of a design which permits inside access to all deck machinery. Other features include unit replacement of all subassemblies, a built-in counterweight to shorten rear end clearance of cab, 16-in. diameter drums for increased life of the wire rope, and antifriction bearings throughout. For information, write **Wayne Crane Div., American Steel Dredge Co., Inc., Fort Wayne, Indiana**

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Dr. Phelps has worked and taught in the public health field for more than half a century. His collaborator in this volume, Walter D. Tiedeman, has had 25 years' experience with the New York State Health Department.

CONTENTS

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3. Pasteurization of Milk
4. Auxiliary Processes and Equipment. Plant Layout
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Equipment, Materials & Methods (Continued)

Excavator

AN EXCAVATOR WITH MANY important new features has recently appeared on the market. This greatly improved power tool, the Pippin excavator, Model EX-100, is a combination digger and loader attachment for Ford and Ferguson tractors, (application to other tractors can be made). Tractor-powered and hydraulically operated, the Pippin digs, shovels and loads quickly, efficiently and economically. The excavator is precisely

Model EX 100

engineered and sturdily built to perform a variety of functions: it digs and shovels to a full 7-ft depth; back hoes by reversing the regular shovel; digs plumb trenches on side hills up to 15 deg grades; back hoes and front hoes a 22-in.-wide trench—(using a back hoe bucket, back hoes a 24-in.-wide trench); elevates the shovel bucket 10 ft above grade and swings its load laterally in a 110 deg arc. The Pippin is simple to operate. Four lever controls are provided; one lever controls the lateral swing of the shovel bucket, a second lever guides the vertical swing of the boom, another regulates the vertical swing of the the shovel shank, and the fourth lever operates the spade support. Other interesting features are the extra-large surge and reserve tank, the high-grade, heavy-duty pump, the standard 4-valve control with independent pressure ports to provide combination cylinder action, a flow regulator which automatically locks the shovel in position and controls the speed of the shovel's lateral swing and unusually large cylinders which assure ample power at moderate pressures. **Pippin Construction Equipment, Inc., White River Junction, Vt.**

Pre-Casting of Concrete

A DISCOVERY IN THE PRE-CASTING of concrete has recently been made in the commercial production of a new, patented pre-cast headwall. A Protex headwall may save millions of dollars for contractors, government departments and the general public because of the increased quality of concrete which is used, because of saving in construction time, engineering time, material and labor costs. Every contractor knows the problem of pouring concrete headwall; the problems of hauling good aggregate and sand many miles to make a small pour; and the impossibility of limiting loss on the building

(*Continued on page 90*)

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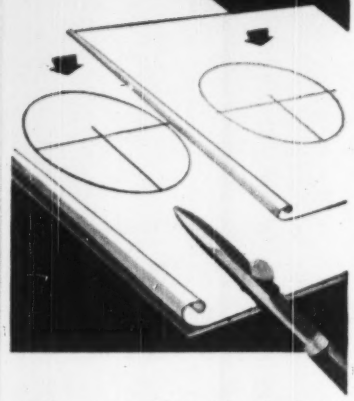

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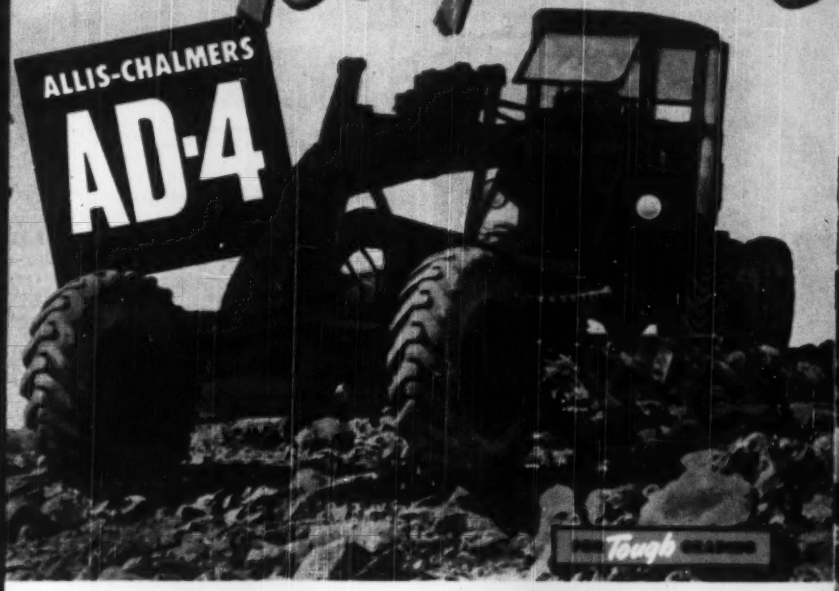

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Equipment, Materials & Methods (Continued)

of headwalls. The old "per yard price" for the concrete in headwalls is eliminated, since the new headwalls are priced per unit and the contractor can make a profit on each one that he places. No concrete forms need be built and the difficulties of pouring under adverse conditions are completely eliminated. Complete protection is given against freezing since each headwall is cured properly against low temperatures. The Protex pre-cast headwall is designed and engineered so that, regardless of angle or skew of the corrugated metal or concrete pipe, it fits perfectly as though cast on the job. This unique feature, making it possible to accommodate the pipe regardless of the direction it takes in coming into the headwall, is one of these special patented features. Full information about the headwall and information regarding franchise rights and franchises for manufacturing rights can be secured by writing the **Protex Industries, 1331 West Evans, P. O. Box 4044, South Denver Station, Denver, Col.**

Precast Headwall

Single-Strap Clamp

A NEW TYPE SINGLE-STRAP clamp simplifies making lateral pipe connections to branch and main pipelines. This product makes unique use of special shaped molded rubber and oil resistant type gaskets to effect a leak-proof seal for the clamp. A principal feature is a wedging action of the resilient gasket which develops partly from hydraulic pressure within the pipe plus only a moderate tightening of the strap nuts. The taper seal idea was originally developed for use on asbestos-cement pipes but is now in production for light wall steel pipes. Extra-wide arc saddles are said to avoid the extreme crushing pressure formerly required to properly seat metallic type gaskets. Further information has been made available by **Smith-Blair, Inc., South San Francisco, Calif.**

When Requesting Literature, Please Tell The Manufacturers You Saw Their Products Mentioned in Civil Engineering

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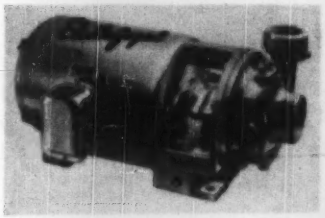
Equipment, Materials & Methods (Continued)

Electrifugal Pump

A REDESIGNED CLOSE-COUPLED electrifugal pump and motor with internal and external design changes to provide improved operating characteristics and greater ease in maintenance has been announced. The improved unit has new



Features New Sealed Motor Bearings

sealed motor bearings; a unit-cast frame which provides perfect and permanent alignment; double seal on front motor bearing which keeps liquid out of the bearing under normal operating conditions, and a large opening in the frame between the pump and motor to make packing maintenance quick and easy. Its all cast iron construction resists corrosive atmospheres. The pump is available with removable casing in some sizes and with removable cover plate in others. It can be had in ratings from 10 to 500 gallons per minute at heads to 220 ft. The motor is designed and built especially for the electrifugal pump. It has a double-dipped and double-baked stator, a rotor of pressure die-cast aluminum construction, and ventilating fans which move the air from the rear of the motor to the pump end. Motors range in size from ½ to 10 hp. They are available in drip-proof, splash-proof, totally-enclosed fan-cooled or explosion-proof types. **Allis-Chalmers Mfg. Co., Milwaukee, Wis.**

Crawler Tractor

THE MODEL GT-25 TERRATRAC crawler tractors are now coming off the assembly lines. Units are amply powered by a 4 cyl., Continental Red Seal Industrial gasoline engine, which provides over 20 drawbar h.p. and 25 belt h.p. The GT-25 Terratracs feature Clark transmissions, Warner gears, Spicer universal joints, Auto-Lite ignition, Donaldson air cleaners, Fram filters and anti-friction bearings throughout. Other features include positive crawler traction for all-weather operation, high clearance—over 20", track gauges to meet varying requirements—from 36" to 72" wide, hydraulic system for operating a wide range of attachments such as bulldozers, loaders, winches earth drills, cranes and snow plows. Literature and complete specifications are available on request, from the **American Tractor Corp., 200 Fort Wayne St., Churubusco, Indiana.**

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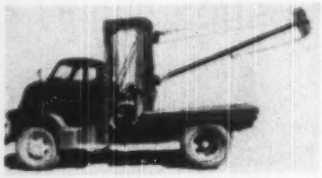
Equipment, Materials & Methods (Continued)

Hydraulic Truck Crane

HYDRA-LIFT IS A VERSATILE, mobile truck crane that can be easily installed on any type of truck and used with any make winch. It is less expensive to maintain, because there are no gears or clutches to wear out. Operation is

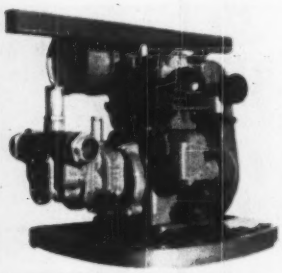


The Hydra-Lift

simple—the truck driver can control all swinging and lifting from his cab with excellent visibility. Operational and design features of Hydra-Lift include: Positive action, full 180 deg swing, full 100 deg lift, telescopic boom, sturdy construction, outriggers, power, safety, mobility, and big capacity. A partial list of uses for the truck crane are: handling pipe, logs, telephone poles, bottled gas tanks, package freight, airplane engines, blasting mats, tombstones, structural steel, road forms, boats, cargo, scrap, concrete. **Pitman Mfg. Co., 300 W. 79th Terrace, Kansas City 2, Mo.**

Porto Pump

RADICAL CHANGES and developments have been made in the Porto pump. This rotary, positive displacement, rubber gear pump is especially applicable for pressure testing and chlorinating water mains.



Features Rubber Gear Construction

The compact pump is easily carried, simple to operate, dependable, and quickly develops required pressures up to 200 lbs. and delivers g.p.m. at free flow. The pump has rubber gear construction, pre-lubricated bearings, mechanical seals (no packing), adjustable automatic by-pass valve, 4 cycle engine, and assures maximum trouble-free performance with minimum maintenance and servicing. It also has unusual value for fire fighting purposes because it can take water from any source, is easily portable, and delivers the necessary flow and pressure for this purpose. **PortoPump, Inc., 227 Iron Street, Detroit 7, Mich.**

Literature Available

DEEP WELL TURBINE PUMPS—Identified as Bulletin No. 4700, the 20-page booklet has illustrations showing construction details, various types of drive and typical installations of deep well turbine pumps. Graphic portrayal of details is obtained by the use of color printing in construction views. **The Deming Co., Salem, Ohio.**

PUMPS—A 16-page bulletin, "Layne Short Coupled Service Pumps," contains cut-away drawings of pump bowls and discharge column. Sixteen sketches show the Layne vertical turbine pump applied to river and re-lift service, boosting, recirculation, cooling tower, drainage, gas and oil pumping, and fire pumps. **Layne & Bowler, Inc., Memphis, Tenn.**

HARD-FACING MANUAL—A 40-page booklet, "Haynes Alloys—Hard-Facing Manual," tells the complete story of hard facing. It describes how to select the right alloy; which welding process to use; and gives simple, step-by-step instructions for applying the various rods by both the oxyacetylene and metallic-arc welding processes. Information is given on the properties and available sizes of 12 Haynes hard-facing materials. **Haynes Stellite Div., Union Carbide and Carbon Corp., 725 S. Lindsay St., Kokomo, Ind.**

STEEL DERRICKS—A complete line of steel derricks, with capacities of up to 250 tons, is shown in a 36-page catalog, No. 200-D-3. The six different types of derricks are treated separately in sections which include complete specifications, outline drawings and full page operating pictures. Following these sections are complete construction details from boom point to sill connections. Copies may be obtained by writing to the **American Hoist & Derrick Co., Advertising Dept., St. Paul 1, Minnesota.**

CONCRETE WEIGHTS & PACKAGE BRIDGES—Illustrated brochures on "Concrete River Weights" and "Concrete Package Bridges" are available. The first publication shows photos of actual use of river weights to safeguard gas lines crossing the Tennessee River. Engineering specifications are also given. The second publication, a 12-page booklet, shows how precast concrete cribbing and bridge deck slabs combine to speed bridge construction and repair. **Universal Concrete Pipe Co., 297 S. High St., Columbus, Ohio.**

FLOCSETTLER—A complete 8-page Technical Supplement FL describing the modern American flocsettler for water and waste treatment has been published. Illustrations and detailed data fully explain how it combines in one compact unit all of the modern features of water and waste treatment including mixing and slurry blending, flocculation and softening, slurry recirculation and slurry blanket, settling and sludge concentration, and positive sludge removal. Individual diagrams show the positive, controlled action within the flocsettler. Each feature is clearly described. A copy may be obtained by writing the **American Well Works, Aurora, Ill.**

(*Continued on page 95*)

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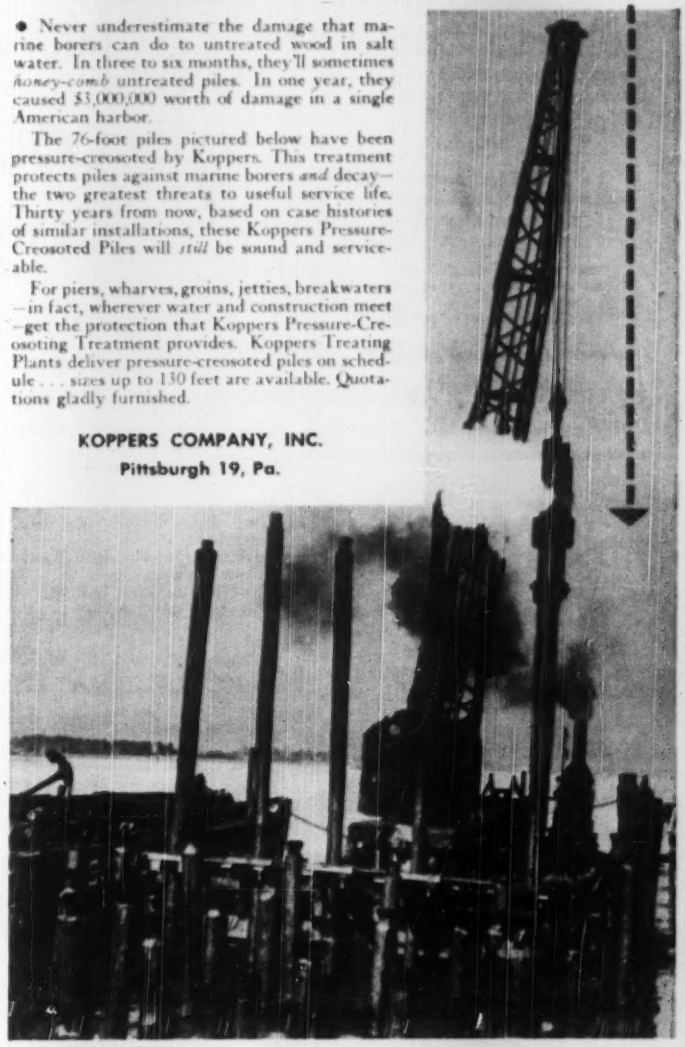

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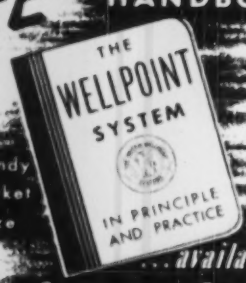

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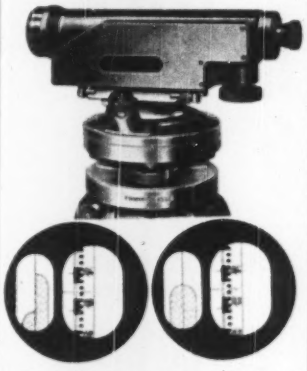
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Literature Available (Continued)

SELF-PRIMING PUMP—Complete information on the new self-priming centrifugal pump line is now available. The pumps are of a new design that eliminates valves and yet gives efficiency comparable to standard centrifugal pumps. Write for Bulletin 636.1. **Goulds Pumps, Inc., Seneca Falls, N. Y.**

PLOW STEEL WIRE ROPE—A bulletin called "Monarch Whyte Strand Bulletin No. 50-25" condenses and combines information on improved plow steel wire ropes for the first time. It is four pages, and contains information on how to order wire rope, and explains and describes wire rope constructions. All sizes and construction classifications are combined in one large table. A copy may be had by writing to **Macwhyte Co., Advertising Dept., Kenosha, Wisconsin.**

SEWER JOINT COMPOUND—The publication of Bulletin No. M20-1, "Atlas G-K Sewer Joint Compound," is announced. G-K Compound is the original bituminous jointing compound and has been used for almost a half century to make quality, permanent joints. The bulletin contains handy tables showing the quantities of G-K Compound required per joint of sewer pipe. Write to **Atlas Mineral Products Co., 10 Pine Street, Mertztown, Pa.**

CEMENT—The publication of Bulletin No. 5-1 on corrosion proof cements, has been announced. This bulletin describes Atlas' complete line of resin, sulfur, silicate and asphaltic cements. Information on each cement is compiled in handy chart form which is helpful in the selection of the correct cement for a specific application. Also included in the bulletin is information on Alkor 5E the nearest thing to a universal corrosion-resistant cement. Write to **Atlas Mineral Products Co., 43 Walnut Street, Mertztown, Pa.**

TREATED LUMBER—A 44-page, illustrated report covering 25 years of service records for "Wolmanized" pressure-treated lumber has been published. This report cites the case histories of more than 55,000,000 board feet of treated material in service and lists 581 specific installations where this clean-treated, decay and termite-resistant wood has been used. The file is considered to be the most extensive in the wood preserving industry. Copies are available from the **Technical Dept., American Lumber & Treating Co., 332 So. Michigan Ave., Chicago, Ill.**

FLAMMABLE MATERIALS—The booklet, "Properties of Flammable Liquids, Gases and Solids," is an indispensable source book for fire prevention engineers. Key feature of the work is a table of more than 650 flammable materials found in industrial plants, giving for each the chemical formula, flash point, explosive limits, auto-ignition temperature, specific gravity and other data. The 1950 edition has more than 200 materials not previously listed as well as additional information on previous listings. **Engineering Div., Associated Factory Mutual Fire Insurance Companies, 184 High St., Boston 10, Mass.**

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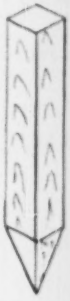
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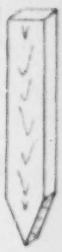
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Literature Available (Continued)

COMPRESSORS—A new bulletin describing the "T" series stationary air compressors is offered. The series consists of two lines, one designed for normal industrial pressures of 100–125 lbs; the other rated at 200 lbs for continuous service, and up to 250 lbs on intermittent pump-up service. Both lines are available as tank-mounted, baseplate-mounted or bare units, with electric motor or gasoline engine drive. The bulletin shows various sizes and models and gives cross-sectional views, engineering data, sizes and dimensions. For additional information request Form 1048, **Ingersoll-Rand, 11 Broadway, New York 4, N.Y.**

CENTRIFUGAL PUMP GUIDE—Economical pumping units for every industry are catalogued in a 16-page "Handy Guide to Selection of Centrifugal Pumps." A wide variety of units are indexed in this bulletin including close-coupled, pedestal, double suction single stage, multistage, self-priming, fractional horsepower, coolant and circulating, fire, process, solids handling, marine, rubber-lined, paper pulp, sewage, axial and mixed flow pumps. Head capacity charts and tables for various types of the pumps are given along with data on sizes, capacities and construction features. Copies of Bulletin 52B6059C, are available upon request from **Allis-Chalmers Mfg. Co., 1187 S. 70th St., Milwaukee, Wis.**

CALCIUM CHLORIDE—A recent booklet titled, "The Why of Wyandotte Calcium Chloride for Roads," has been published. It was primarily written for state and county highway commissioners and engineers, township supervisors, etc. Particular attention has been paid pictorially and editorially, to the practical problems of people concerned with maintenance of gravel and stone road surfaces. Such vexing questions as gravel loss, high blading costs, spring breakup, stable bases for future surfacing, are aptly discussed. This booklet is all factual, discussing the circumstances where calcium chloride will not work, as well as where it can be advantageously employed. Copies of this book are available upon request from **Wyandotte Chemicals Corp., Calcium Chloride Dept., (CIE) Michigan Alkali Division, Wyandotte, Michigan.**

RECORDING GAUGE—A 32-page bulletin on the "Series 500" line of recording gauges has just been published. Complete information is given on pressure gauges, vacuum gauges, low range draft and pressure gauges, barometers, and absolute pressure gauges for ranges as low as 0 to 6 millimeters of mercury absolute. Measuring elements, operating principles, recording charts and accessories for the various types of recording gauges are fully described. Information is also included on Bristol instruments for automatic controlling and telemetering of pressure and vacuum valves. In addition to numerous photographs, the bulletin is liberally illustrated with reproductions of actual chart records and sketches of applications of the instruments. Bulletin C621 is available from **The Bristol Company, Waterbury 20, Conn.**

TIDE GATES

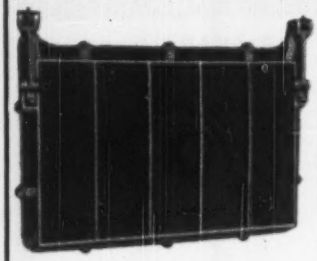

Fig. B-61. Type M-M

Type M-M (Rectangular) Tide Gates are available in 37 sizes from 8" x 8" to 96" x 96". Bulletin No. 71 describes them fully.

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Closed to Further Discussion

6. Slope Deflection Equations for Curved Members by Keith T. Fowler, Jun. M. ASCE.

7. The Geochemistry of Earthwork by Hyde Forbes, M. ASCE.

8. Floating Tunnel for Long Water Crossings by Charles E. Andrew, M. ASCE.

9. Atchafalaya River Diversion and Its Effect on the Mississippi River by Leo M. Odom, M. ASCE.

10. Pollution Abatement Policy by Thomas R. Camp, M. ASCE.

11. Long-Term Storage Capacity of Reservoirs by H. E. Hurst.

12. Influence Charts for Concrete Pavements by Gerald Pickett and Gordon K. Ray, Jun. M. ASCE.

13. Reinforced Concrete Skewed Rigid-Frame and Arch Bridges by Maurice Barron, M. ASCE.

14. Mathematical Analysis of an Aerial Survey by Lo-Ho.

15. Computation of Equitable Charges for Treatment of Municipal Sewage by Ellis E. Bankson, M. ASCE.

D-VII. Discussion of Paper, **Deflection of Plywood Beams Due to Moisture Content Change,** by W. E. Wilson and Laurence G. Olson.

16. Pavement Bearing Capacity Computed by Theory of Layered Systems by Guthlac Wilson, M. ASCE, and G. M. J. Williams, Jun. M. ASCE.

17. Origin and Significance of Openwork Gravel by Allen S. Cary, Assoc. M. ASCE.

18. Successive Approximations for Beams on an Elastic Foundation by E. P. Popov, Assoc. M. ASCE.

19. Flood-Control Operation of Tennessee Valley Authority Reservoirs by Edward J. Rutter, M. ASCE.

20. Three-Dimensional Displacement Diagrams for Space Frame Structures by Walter Worthington Ewell, Jun. M. ASCE.

21. Maximum Load Capacity of Bailey Bridges by Robert B. Stegmaier, Jr., Jun. M. ASCE.

22. Specifications for Heavy Duty Structures of High-Strength Aluminum Alloy, Progress Report of the Committee of the ASCE Structural Division on Design in Lightweight Structural Alloys.

23. Influence of Heavy Loads on Pavement Design Trends by K. B. Woods, M. ASCE.

24. Summary of Buckling of Rigid-Jointed Plane Trusses by N. J. Hoff, Bruno A. Boley, S. V. Nardo, and Sara Kaufman.

25. Uplift Pressures in Concrete Dams by Kenneth B. Keener, M. ASCE.

Summarized in Earlier Issues

D-XVI. Discussion of Paper, **Stream Flow Variability,** by E. W. Lane and Kai Lei.

D-XVII. Discussion of Paper, **End Restraints on Truss Members,** by Harold E. Wessman and Thomas C. Kavanagh.

D-XVIII. Discussion of Paper, **Frequency Analysis of Beam and Girder Floors,** by Hans H. Bleich.

D-XIX. Discussion of Paper, **Roads and Pavements, Sampson Naval Training Station,** by Jacob Feld.

D-XX. Discussion of Paper, **Aerodynamic Theory of Bridge Oscillations,** by D. B. Steinman.

26. Industrial Stream Pollution Abatement, by L. L. Hedgepeth.

27. Plasticity of Metals—Mathematical Theory and Structural Applications, by D. C. Drucker, Assoc. M. ASCE.

28. Retrogression on the Colorado River Since 1935, by J. W. Stanley.

29. Sedimentation Studies at Conchas Reservoir in New Mexico, by D. C. Bondurant, Assoc. M. ASCE.

30. Economic Effects of Reservoir Sedimentation, by W. E. Corfitsen, M. ASCE.

31. Measurement and Analysis of Suspended Sediment Loads in Streams, by Martin E. Nelson and Paul C. Benedict.

32. Effect of Skew Angle on Rigid-Frame Reactions, by Walter C. Boyer.

33. Strength of I-Beams in Combined Bending and Torsion, by Basil Sourochnikoff.

34. Lateral Buckling of Eccentrically Loaded I-Section Columns, by H. N. Hill and J. W. Clark.

35. Design Curves for Footings on Soil, by Winfield A. McCracken.

D-XXII. Discussion of Paper, **Analytical Method of Determining the Length of Transition Spiral,** by Michael V. Smirnoff.

D-XXIV. Discussion of Paper, **Diversion Tunnel and Power Conduit of Nantahala Hydroelectric Development,** by D. J. Bleifuss.

Third Notice

36. Impossibility of Performance in Contracts for Engineering and Construction, by Robert F. Borg. When will an agreement for a project be excused as impossible of performance? A practicing contracting engineer (who is also a member of the New York State Bar) examines, from an engineer's point of view, a problem that has resulted in many law cases. The established rule forbids excuse for impossibility, but the numerous and various exceptions are grouped and described. The purpose is to enlist the discussion and aid of the engineering profession in assisting the courts to solve this ever difficult problem. (Available November 1.)

37. Design of Prestressed Tanks, by J. M. Crom. The author's experience in supervising the design and construction of more than 500 prestressed circular concrete tanks forms the basis of this analysis of the design principles involved. Substantial losses of stress occur in the prestressing steel as a result of shrinkage and plastic flow in the concrete. With low initial stresses in the prestressing steel, after de-

INSTRUCTIONS

1. Papers are to be ordered by serial number. Please keep record of Separates you have ordered to avoid unwanted duplication.

2. Any ASCE member may order a total of 25 copies of papers during the fiscal year ending September 30, 1950, without charge. These may be duplicates of the same paper, separate papers, or a combination of both.

3. Members' accounts will be charged at 25¢ each for orders exceeding 25 copies in a fiscal year. Charges for excess copies or for subscriptions will be included on the 1951 dues bills.

4. Non-members of the Society may order copies of PROCEEDINGS papers by letter with remittance of 50¢ per copy; members of Student Chapters 25¢ per copy.

5. Discussions of each paper, with author's closure, also will be published as a Separate and must be ordered in the same manner as other Separates, except that no charge will be made for the discussions of a paper previously ordered. The order form will list available discussions of papers. Discussions will be numbered to agree with the basic paper.

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fecting losses due to shrinkage and plastic flow, the effectiveness of prestressing is largely nullified. This emphasizes the advantages in prestressing with high-strength steel wire having initial design stresses of about 150,000 lb per sq in. (Available November 1.)

38. Hydrology of Mexico, by Andrés García-Quintero. All the factors that must be considered to account for the relative scarcity of rainfall in Mexico—such as geographical position in relation to air currents, cyclones, and air masses; topography; and mountain ranges that determine distribution of rainfall and consequently hydrology—are reviewed. The paper is completed by a table of maximum discharges observed in Mexican rivers and graphs that will enable comparisons with rivers of other countries. (Available November 1.)

39. Practical Design of Solid-Barrel, Reinforced-Concrete Skew Structures, by Bernard L. Weiner. The purpose of this paper is to show that, with sufficient accuracy for design purposes, the work involved in designing a skew structure may be reduced to little more than that required for a similar right-angle structure. Part of the work is reduced by making certain approximations which are permissible because of the stress characteristics of the skew structure. The work is further reduced by taking advantage of factors that follow directly from consideration of static equilibrium and are independent of skew-arch theories. (Available November 1.)

40. Technique of Passing Floods Over Earth Dams During Construction, by Andrew Weiss. An unvarnished account of success and partial failure in permitting flood flows to pass unhindered over uncompleted earth and rock-fill dams during construction is offered by the author. This necessity arises when absence of sufficient hydrologic data renders conventional by-pass provisions unsafe, as in Mexico, where rates of flood discharge in many streams are wholly unpredictable. The technique employed by Mr. Weiss (the originator) and his associates has demonstrated its practicability to a degree which invites consideration by engineers elsewhere. (Available November 1.)

D-XXVI. Discussion of Paper, **A Study of End Connections for Struts,** by Marshall Holt and J. W. Clark. The original paper, published in December 1949 PROCEEDINGS (p. 1477), presented the results of tests to evaluate the effect of different types of end connections on the static and fatigue strengths of struts. Interesting comment was received from Jack R. Benjamin, James W. Harland, F. P. Shearwood, and S. K. Ghaswala, and the authors contribute a brief closing discussion. (Available November 1.)

Second Notice

41. Ship Response to Range Action in Harbor Basins, by Basil Wrigley Wilson. In many harbors the troublesome movements of ships are the results of range or surge action. The paper treats the conditions prevailing at Capetown, South Africa, but its generalizations are applicable almost anywhere. The influences of moorings, size, draft, and location of a ship in a harbor are examined with reference to longitudinal and transverse surging, and the conditions of resonant response are evaluated. Theoretical deductions are confirmed by model experiments and prototype measurements. The periods of dangerous surges are defined and suggestions are offered for eliminating or minimizing the motion. (Available December 1.)

42. Wind-Load Standards in Europe, by John W. T. Van Erp. Since some decades it has been endeavored to obtain a more accurate picture of wind loads on buildings and structures, about which little precise data existed. As the utmost economy in the amount of material used has always been more necessary in Europe than in the United States, investigation of the exact nature of wind loads has been more advanced than in this country. This paper reviews various aspects of the problem and the way in which safety standards have been determined. (Available December 1.)

43. Settlement Correction at La Guardia Field, by John M. Kyle. After its establishment as an airport for the City of New York, N.Y., a part of La Guardia Field was observed to settle. On several occasions prior to August 1946, unusual storms and high tides drove sea water over this area, making it unfit for use during considerable periods. The paper describes the sequence of construction operations required to correct the situation. (Available December 1.)

44. The Problem of Wave Action on Earth Slopes, by Martin A. Mason. Wave action on earth slopes and the possible application of wartime developments to the knowledge of wave action, particularly in regard to methods for the prediction of wave action, is discussed in this paper. The Sverdrup-Munk method of predicting wave height and period from synoptic weather maps is recommended as a substitute for the older purely empirical methods. The Iribarren formula for the calculation of sizes of stone required on various slopes for protection against wave action is suggested as the only available satisfactory method of design. (Available December 1.)

45. Comprehensive Plan for the Columbia Basin, by William Whipple. Cooperative planning of several government agencies has resulted in congressional authorization of an unprecedentedly large system of multiple-purpose reservoirs and related works for the Columbia Basin. The Grand Coulee, Bonneville, and McNary projects are only initial units of this system, which will ultimately have a 10,000,000-kw output. The planning involved a variety of different problems including preservation of migrating salmon, priorities of water use for irrigation, and reliable flood control in a multiple-purpose system. (Available December 1.)

D-4. Discussion of Paper, **Capillary Phenomena in Cohesionless Soils,** by T. William Lambe. The original paper, published in February 1950, explained the fundamentals of capillarity in cohesionless soils. Discussers are: M. R. Lewis, Peng Swe-tze, D. P. Krynine, and T. William Lambe. (Available December 1.)

D-5. Discussion of Paper, **Elastic Restraint Equations for Semi-Rigid Connections,** by J. E. Lothers. The original paper, published in February 1950, discussed the restraining effects of semirigid, girder-column connections. Discussers are: Lloyd T. Cheney, Thomas C. Kavanagh, Dean F. Peterson, Jr., and Jack E. Cermak, and J. E. Lothers. (Available December 1.)

D-10. Discussion of Paper, **Pollution Abatement Policy,** by Thomas R. Camp. The original paper, published in March 1950, outlined a policy to guide engineers and others interested in pollution abatement. Discussers are: J. E. McKee, Elwood L. Bean, and Thomas R. Camp. (Available December 1.)

First Notice

D-XXIII. Discussion of Symposium, **High-Velocity Flow in Open Channels.** The original symposium, published in November 1949 PROCEEDINGS (p. 1287), treated the broad applicability of elastic wave analysis of problems of high-velocity flow arising from changes in open-channel cross section. Discussers are: Paul Baumann; N. N. Bhandari; T. Blench; Clarence A. Hart; Fred W. Blaisdell, J. H. Douma; Arthur T. Ippen; Robert T. Knapp; and Hunter Rouse. B. V. Bhoota, and En-Yun Hsu. (Available December 1.)

D-XXVIII. Discussion of Paper, **Movements in the Dessicated Alkaline Soils of Burma,** by F. L. D. Woolterton. The original paper, published in January 1950 PROCEEDINGS (p. 63), described vertical movements in the tropical soils of the Mandalay District. Discussers are: Hans F. Winterkorn, J. E. Jennings, and F. L. D. Woolterton. (Available December 1.)

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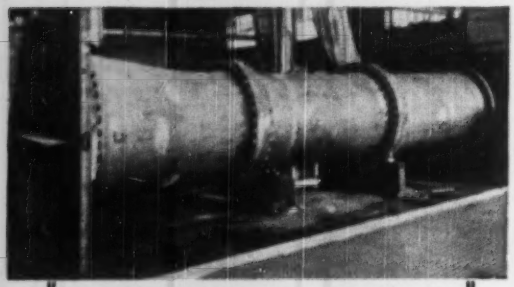

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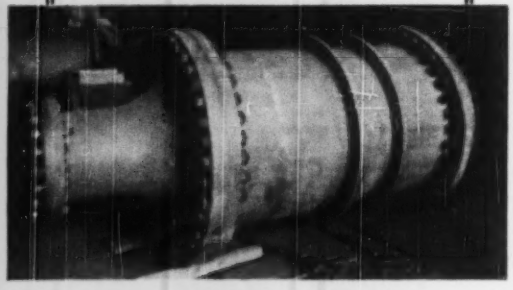

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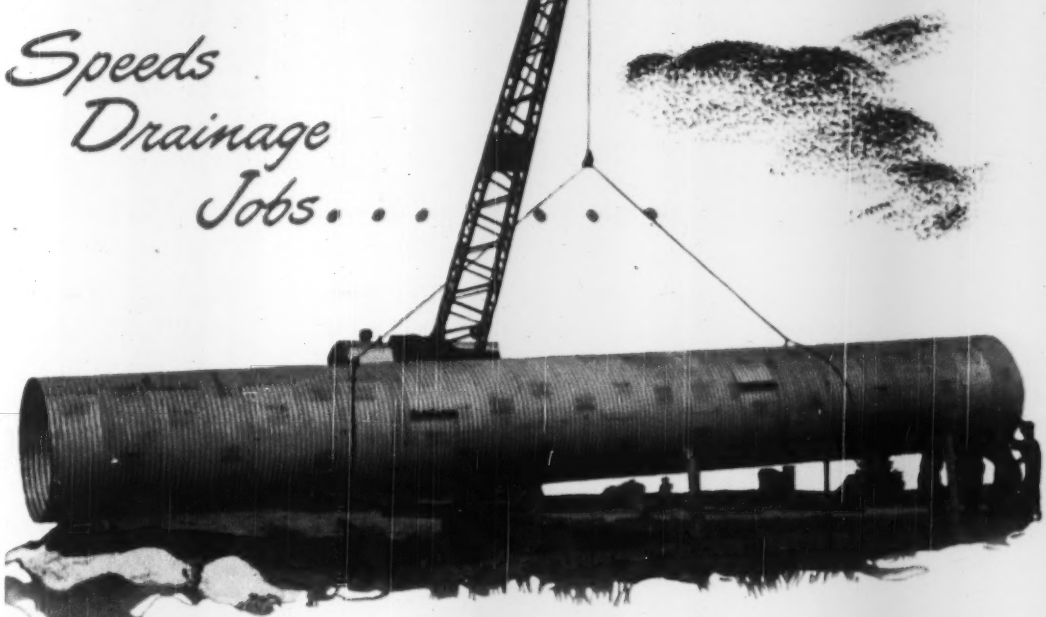
TONCAN® IRON

CORRUGATED METAL PIPE

Speeds Drainage Jobs . . .



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EATON METAL PROD. CO. of MONTANA
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● Toncan Iron Corrugated Metal Pipe goes in fast. It is light in weight—easy to handle and haul. It goes together fast, too. Unskilled labor can keep jobs moving on schedule—in any weather.

Once in place, Toncan Iron Corrugated Metal Pipe serves for years. It is strong and resilient—able to carry heavy loads—to stand up under vibration, earth settlement and weather changes without cracking or crumbling.

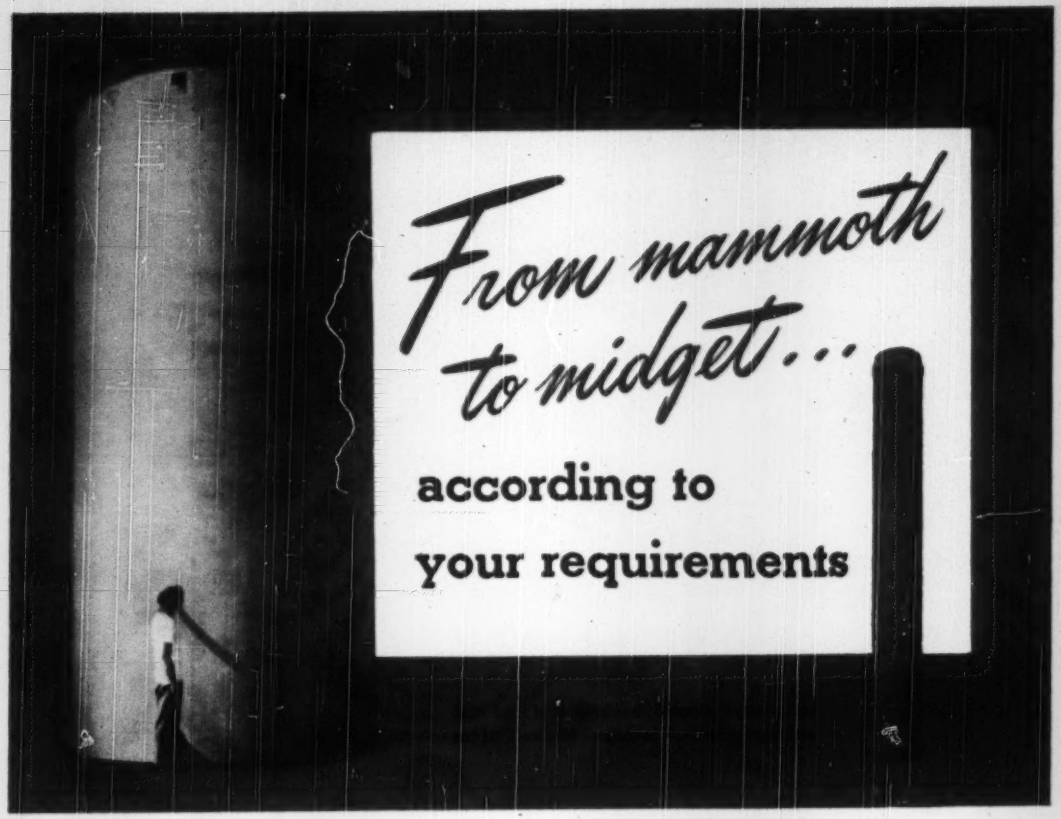
Best of all, Toncan Iron has the highest rust-resistance of any ferrous metal in its price class. It's an alloyed iron containing twice as much copper as copper-bearing steels and irons *PLUS* just the right amount of molybdenum to bring out the full effect of the copper.

Get the most for your money in drainage structures. See your nearest Toncan Iron Drainage Product Manufacturer — or write us.

REPUBLIC STEEL CORPORATION • GENERAL OFFICES: CLEVELAND 1, OHIO

Toncan Copper Molybdenum Iron is available in:

CORRUGATED METAL PIPE • PERFORATED CORRUGATED METAL PIPE • SECTIONAL PLATE PIPE
SECTIONAL PLATE ARCHES • CORRUGATED METAL PIPE-ARCH • SECTIONAL PLATE PIPE-ARCH
CORWEL SUBDRAINAGE PIPE • BITUMINOUS COATED AND PAVED PIPE



Whether your daily water consumption demands be 3,000,000 gallons or hundreds of times that figure, Lock Joint Pipe Company is prepared to provide a supply line for your requirements.

In the last few years the Company has supplied not only hundreds of miles of large diameter pipe but also more than a million feet of 16" to 24" pipe for municipalities and industry. This has been made possible through the establishment of three permanent manufacturing plants. Lock Joint Concrete Pressure Pipe from 16" to 42" in diameter, produced at these plants, can be shipped economically to all parts of the country —for both major installations and minor extensions.

Our representative will be glad to discuss with you any water supply or transmission project which calls for pressure pipe 16" in diameter or larger. You will find that Lock Joint Concrete Pressure Pipe's superior characteristics of long life, continuous high flow and negligible upkeep will recommend it above all others for any permanent water supply installation.

SCOPE OF SERVICES—Lock Joint Pipe Company specializes in the manufacture and installation of Reinforced Concrete Pressure Pipe for Water Supply and Distribution Mains in a wide range of diameters as well as Concrete Pipe of all types for Sanitary Sewers, Storm Drains, Culverts and Subaqueous Lines.

LOCK JOINT PIPE COMPANY

Est. 1905

P.O. Box 269, East Orange, N. J.

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